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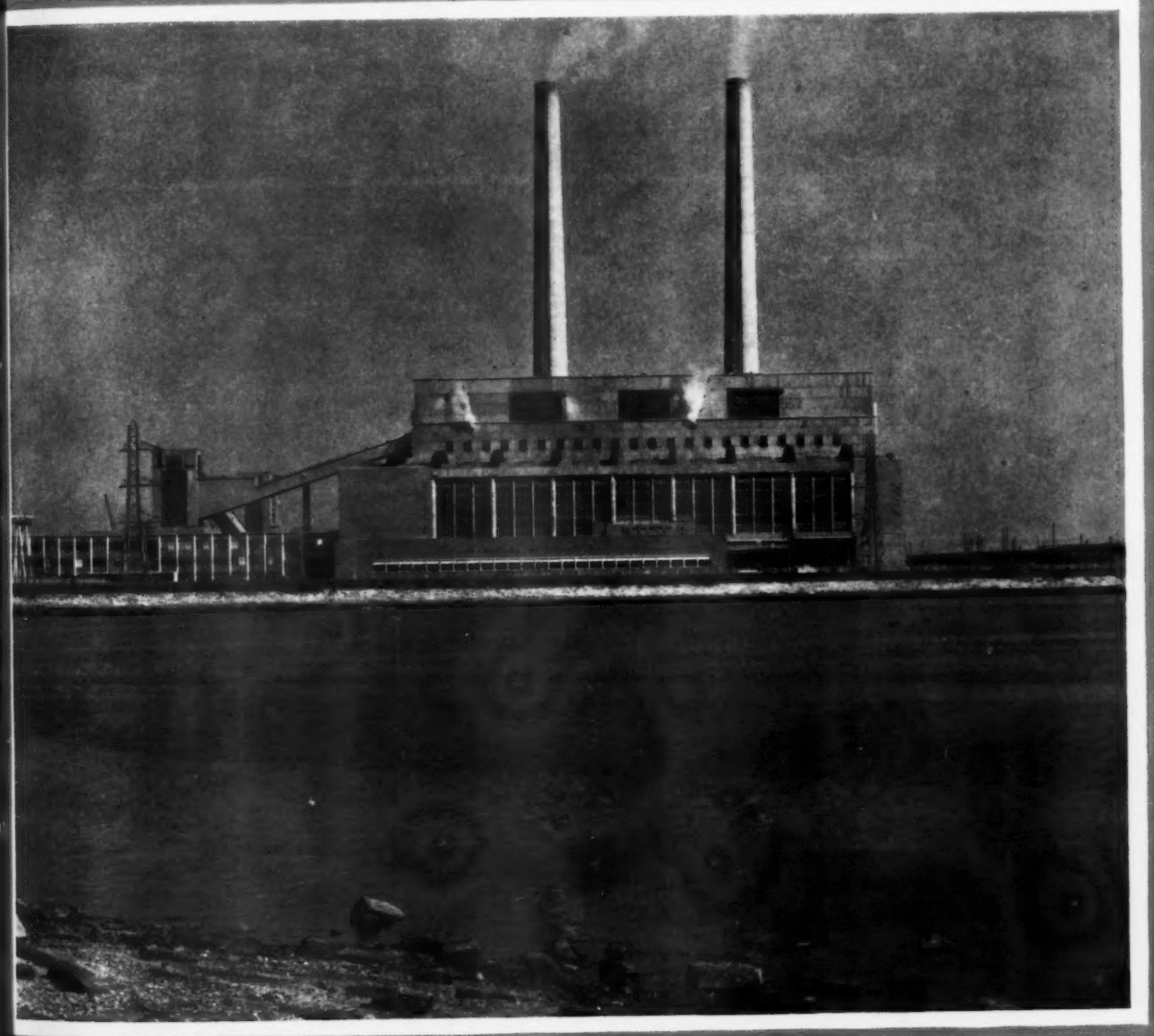

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CONVENTIONAL COMPETITION

'SAILING' into the centre of the stage in this month's cover picture is Blyth A power station of the North Eastern Division of the Central Electricity Generating Board, seen from the opposite bank of the River Blyth. This new coal-fired installation, commissioned in December 1958, was the most efficient C.E.G.B. station in 1959.

The greatly increased efficiency of conventional establishments such as this has been a significant factor in the British Government's recent 'deferment of acceleration' of nuclear-power-station construction.

Aspects of the keen competition between nuclear and conventional installations are discussed in the Foreword on p. 471 and in the report on p. 481 of the recent Sectional Meeting in Madrid of the World Power Conference

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JOURNAL

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SAVOY PLACE LONDON W.C.2 VOLUME 6 NUMBER 68 AUGUST 1960

THE NUCLEAR-POWER PROGRAMME

THE recent White Paper announcing a slowing down in the British nuclear-power programme caused something of a furore in political circles, but came as little surprise to those more closely concerned with the generation of electricity.

At the present time, there are five nuclear stations under construction, totalling nearly 2000 MW; and contracts for two other stations, at Dungeness and Sizewell, are likely to be placed before the end of 1960, bringing the total up to nearly 3000 MW. The new programme proposes that additional stations should be ordered at the rate of only about one per annum so that 5000 MW will be in commission by 1968.

The original programme published in 1955 provided for 1500–2000 MW by 1965. In March 1957, the Government stepped this up to 5000–6000 MW, but later in the same year extended the date to 1966. The new programme means that, up to the end of 1966, the capacity of nuclear plant to be commissioned will be about 4000 MW, or 1300 MW less than previously planned, with a deferment of some £90 million of capital investment. As the Minister of Power explained in the House of Commons, this is a 'deferment of acceleration' rather than a cancellation.

The main reason for the change in plan is the remarkable somersault in the national fuel position over the past two or three years. At the time of the original White Paper of 1955, fuel was still in very short supply. Domestic-coal rationing was in force and indeed continued so until July 1958. The supply industry was faced with the problem of making ends meet in circumstances where the demand for electricity continued to increase at an appreciably higher rate than any foreseeable increase in the rate of coal production.

On that outlook there was a compelling case to seek and plan for other sources of primary energy. The only immediate palliative lay in the importation of oil or foreign coal, and in fact a decision was taken to burn oil fuel at a number of existing and proposed stations. At the same time, the Government announced the decision to go right ahead with the first round of nuclear stations, even though 18 months were still to go before the commissioning of Calder Hall.

The supply industry may have had some reservations and misgivings about this programme, but, in the circumstances of the time, it was accepted as a necessary and workable plan. The trebling of the programme in 1957, as a result of anxiety about our dependence on imported oil fuel following Suez, had to be accepted on the grounds of expediency.

However, before 1957 had passed, a startling change was taking place. The total home consumption of all fuel, including oil, which had shown a fairly constant increase year by year for more than 20 years, started to decline. Concurrently, the consumption of oil continued to increase, with the result that the supply of small coal soon overtook the demand, and stocks rapidly accumulated. The same situation arose in Europe, where most of the coal-producing countries have been embarrassed by an excess of supply over demand.

It would be out of place here to attempt a detailed examination of the causes, but the main contributory factors include a series of rather mild winters, improved efficiency of use, a slackening of industrial activity, and substitution of oil for coal in industry, on the railways and in commercial and domestic premises, as well as in generating stations. Some of these factors are transitory and non-recurrent, and there are many others which could result in another sudden change in the delicate balance between supply and demand. However, on current outlook it is clear that expediency no longer dominates the situation and that the pace of nuclear development should be governed by the normal interplay of economic considerations and engineering judgment.

The White Paper states that, for stations designed today, nuclear-power costs will be about 25% higher than conventional-power costs but that for future base-load generation the costs are likely to break even about 1970. Nuclear-station costs are said to be following closely the trend foreseen in 1957, but the costs of

conventional stations have also fallen at a rate which was not foreseen, owing to the reduction in capital costs brought about by the use of larger units and the increased thermal efficiency obtained from higher steam conditions. At the same time, the constant upward trend in the price of coal for electricity generation has flattened out. In the decade from 1947 to 1957, the increase amounted to 70%, but no further increase has occurred in the past two years; indeed the results show a very slight reduction, owing to more selective buying and a saving in transport charges.

A paper given at the recent Madrid Meeting of the World Power Conference by Sir Christopher Hinton and his colleagues (see p. 481) examined the relative cost trends in some detail and predicted a decrease between 1961 and 1970 of 10% in conventional generation costs, with the possibility of a 50% fall in nuclear costs over the same period.

So much for the background and causes of the change in programme. It remains to assess the engineering consequences.

Supply engineers have reason to feel a degree of relief: first, at this authoritative recognition that the immediate danger of a famine in primary fuel has passed; secondly, that generation costs will not be saddled to the same extent with uneconomic charges for nuclear plant; thirdly, that a smaller proportion of the national generating capacity will be subject to the hazards and uncertainties of an entirely new form of steam production.

The nuclear plant dropped from the programme up to 1966 will be made good by a like capacity of conventional plant, so that there will be no curtailment of the electrical equipment required for the generation and transmission systems, and distribution development will not be checked in any way. The pattern of the supply system will be affected to some extent, as the added capacity of conventional plant is likely to be in larger units sited near the coalfields, but there will thus be less diversion of design and production effort away from the trend towards larger and more advanced boilers and turbo-alternators.

On the other hand, the slower rate of ordering nuclear reactors means less work for the manufacturing consortia and some contraction in their organization and effort. This shrinking of the programme at home, coming on top of disappointing results in the quest for nuclear work oversea, will accentuate the difficulties of holding together all the specialist teams created for the purpose. Manufacturers of highly specialized nuclear instrumentation and control gear will also be adversely affected, as well as the fuel-element activities of the United Kingdom Atomic Energy Authority.

The White Paper asserts that the ordering of one new nuclear station each year should be sufficient to sustain a healthy nuclear-plant industry. This leads to the most controversial aspect of the matter from the engineer's point of view, namely the effect on progress, both in technology and in engineering.

The cautious will point to the very large strides already made, engineering-wise, between Calder Hall and the stations now under construction which have yet to run the gauntlet of commercial operation; they will argue the advantage of deferring further stations until that experience and the results of experimental work in progress are available for building into the new designs. The bold will point to the technical progress made between the first and last nuclear stations already ordered, and argue that the larger the programme the quicker will operational experience emerge and be reflected in new station designs.

The optimum plan is the one that will achieve the best results at any point in time, measured in terms of reliability and the cost of the end-product. On balance, the revised programme seems right and prudent from the engineer's point of view.

THE TRAINING OF GRADUATES

Within the next few months a revised edition of the booklet 'The training of graduates' will be published. This has been prepared by members of the Joint Committee on Practical Training in the Electrical Engineering Industry, which is a committee of engineers appointed by the Council of The Institution and broadly representative of the electrical industry as a whole.

Two features of the report are of immediate interest. The first is the insistence on fully occupying the graduates' mental abilities during training; the second (by no means unrelated) is the emphasis placed on the part played by engineers in training schemes. Ultimate responsibility for the design and operation of a scheme of training must rest with fully qualified engineers, but it is not always convenient or economic to leave the detailed management of the programme in their hands. It is here that Corporate members of The Institution must exercise part of their professional responsibilities. As graduates progress from department to department, they should be welcomed as future colleagues; Chartered Electrical Engineers should be, and should be seen to be, willing and friendly sources of technical information, directing the attention of graduate apprentices to points and problems of particular technical interest.

There is another responsibility to be faced where oversea graduates are concerned. They will expect Chartered Electrical Engineers to speak with authority on the electrical industry as a whole, and on the part played in it by The Institution. Many oversea graduates, particularly those from outside the Commonwealth, find the professional institutions a novel concept and difficult to understand.

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RECENT TRENDS IN CIVIL ENGINEERING

In this article reference is made to the knowledge required of the civil engineer since World War II, and to the difficulties he faces in dealing equitably on the one hand, say, with contractors—who all have individual idiosyncracies and prejudices—and, on the other, with the increasing dispersion of responsibility within the organizations of clients. New equipments and techniques in planning and construction are described and an indication is given of significant differences in outlook in various countries.
Mr. Cochrane is with Sir William Halcrow and Partners, London.

N. J. COCHRANE, B.SC., M.I.C.E.

I INTEND arbitrarily to interpret 'recent' as meaning 'post-World War II'. Though the modern civil engineer still depends on the possession of a well defined streak of common sense, there has been an increase in the range of techniques available for design and construction, and this permits more and more difficult work to be undertaken safely.

Unfortunately this often increases, rather than reduces, the inevitable dilemmas facing the engineer, for, at its crudest, he may have to choose between a simple structure with a trouble-free life of many decades and a more refined and cheaper structure with a shorter life requiring continuous and expensive maintenance. He may also have to take note of the diverse talents, resources, and particular favourite methods of the various contractors who will tender for the work.

There is no direct solution to any of these problems, and in any event the solution would be different in different countries, for some nations are convinced of the rightness of a 'scrap and rebuild' economic policy while others are certain that it is a good thing to build for future generations at some cost in present inconvenience.

Knowledge of other technologies

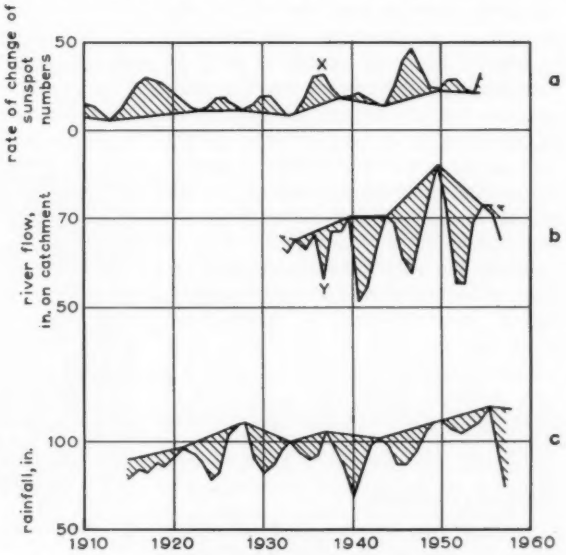
As regards training, almost every British civil engineer now qualifies at a university before starting to practise. His grounding in electrical and mechanical engineering, and in geology, remains adequate, and it is rare to hear of his encroachment on these professions, with whose practitioners he has reached a satisfactory *modus operandi*. That is not the case with several other technologies, and, for his own protection, it is often essential for the civil engineer to know more and more about, say, law, meteorology, climatology, economics, agronomy, soils for agriculture, and other newer physical sciences.

Clients are also more knowledgeable technically than they were, but this, paradoxically, is sometimes accompanied by less assurance and definition in what they really hope to achieve—which can be a very real problem for the civil engineer in many parts of the world.

For example, the promoter of an irrigation or harbour scheme may no longer be a private company, but a Government or a nationalized corporation, with no single person permanently empowered to take decisions or required to understand all about the project. The civil engineer responsible for the scheme may have to discuss relevant Statutory Acts with the official law officers, estimates and finance with the official accountants, soils with the official soil scientists, crops with the official agronomists, hydrology with the official meteorologists, lay-out with the official planners, and disease-carrying insects with the official entomologists.

It will be readily seen that, if every specialist is permitted to include his own allowances for problematical adverse contingencies, the project may soon come to a technically assisted standstill, however good it may be in fact.

It follows that a greater proportion of civil engineering time is normally spent on project work, research, planning, surveys, and design than on actual construction nowadays, and this probably applies even to



1 *Examples of cyclical behaviour in climatic elements*

Points X and Y represent the mean of the three years centred on 1936

a 3-year mean rate of change of sunspots (or turbulence)
b 3-year mean flow in the River Moriston in Scotland
c 3-year mean rainfall on the Essequibo Coast, British Guiana

public works contractors, who have to spend much time on abortive tendering and on planning the jobs they actually succeed in getting.

We may divide civil engineering practice into the investigatory and constructional aspects.

Investigation by models

Hydraulic models are much used to predict the behaviour of real structures or complexes subject to the action of water in nature. Examples include water levels around various parts of large coffer-dams in a flooded river, erosion or deposition of silt or sand in an estuary, progression of hot water from thermal-power-station outfalls, coast erosion, wave action on sea walls, flood levels in river basins, and so on.

The permeation of water through the ground below or around structures is often a serious problem, and flow patterns and pressures are sometimes examined by electrical analogues. If the boundaries can be adequately simulated, the method facilitates the comparison of alternative designs.

The analysis of internal stresses in involved structures has been eased by the use of 'relaxation' techniques of design which may supplant many of the quasi-theoretical, empirical, or photoelastic methods hitherto in use.

Limited application of computers

Digital and analogue computers are as potentially useful to the civil engineer as to anyone else, but so many of our problems are unique that one has to consider carefully whether the few minutes required to produce the solution are worth the weeks or months of work in formulating and setting up the programme and understanding the result. If clients could be persuaded to accept, say, six similar turbine blocks supporting similar turbo-alternators, much might be gained by electronic computation.

There have been significant applications of digital computers to the analysis of the behaviour of complicated river basins, such as the Nile, with various arrangements of reservoirs and controls. Such an analysis is a formidable task without the aid of a computer.

Aids to productivity

In surveying we now have automatic precise levels which, after an approximate adjustment, are optically self-levelling and have greatly increased the speed at which field work can be carried out.

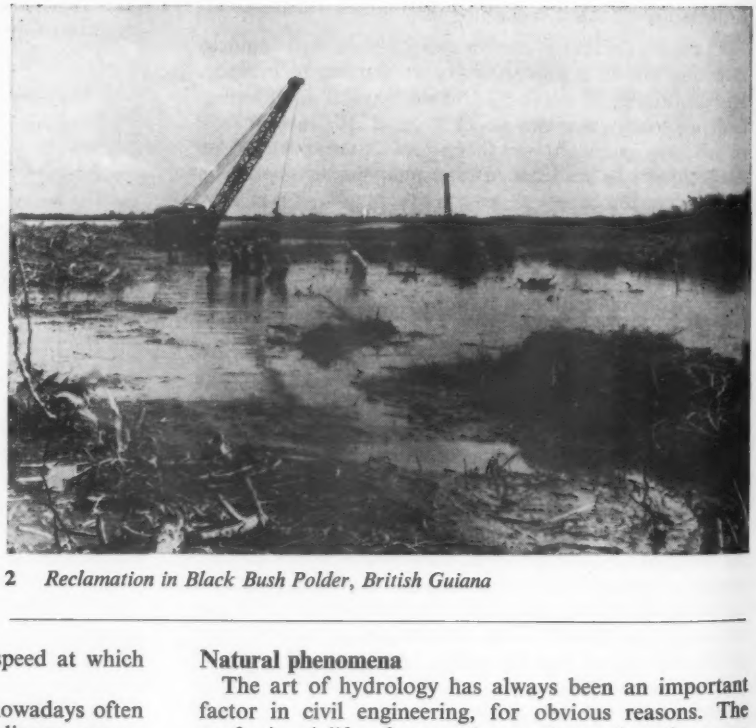
Soundings in the sea or in rivers are nowadays often made by echo sounders, and, for ordinary survey work, very compact and robust transistorized sounders working from dry cells are available which have quite transformed this tedious operation.

We can now obtain compact outboard motors up to at least 60h.p. and small planing hulls, some of glass fibre, of very shallow draught. One no longer chugs up some stifling tropical river at 4 or 5 knots but can rely on 20–30m.p.h., with fuel and heavy stores flown in by helicopter or amphibian. Where road access is poor, it may indeed by economically essential for field parties to use all these aids to productivity.

Long-distance measurements have been simplified by a development of radar which measures distances to unobstructed distant targets. Position-fixers for survey parties still await development, and something in the nature of the hyperbolic radionavigation system often used by aircraft and ships is greatly needed—particularly in the many unmapped countries.

Air surveys of various kinds are in common use, though cloudiness may frustrate the best-planned ventures, and position-fixing and levelling for ground control by land survey can be exasperating and expensive.

Over land itself, 4-wheel-drive cross-country motor vehicles can take one almost anywhere a horse can. However, no attention appears to have been paid to the physiology of the human body in the design of these vehicles and, even if one arrives quickest with the mostest, one may also arrive tiredest.



2 *Reclamation in Black Bush Polder, British Guiana*

Natural phenomena

The art of hydrology has always been an important factor in civil engineering, for obvious reasons. The professional life of an engineer who underestimates a

flood, or overestimates the river flow available in a hydroelectric or irrigation scheme, may be abruptly terminated, for, although a meteorologist may make errors in forecasting weather, society is much less sympathetic to the civil engineer who has to deal with just the same kind of data.

It must also be remembered that the civil engineer is of necessity exposed to the best and the worst that nature can do, and the environment in which he works may be very exacting. Fig. 2 gives some indication of this, but it is of interest to note that, even in these conditions, in British Guiana a determined British firm

3 *Dual carriageway in Accra, Ghana*

There are statistical techniques which purport to deal with natural phenomena, but since the data are usually averages and not events, sometimes cyclical and not randomly occurring, there remain doubts about the validity of some of these methods. For example, Fig. 1 shows the incidence of rainfall in British Guiana and river flow in the Moriston in Scotland, both of which are seen to be significantly cyclic. It is not therefore reasonable to say, as is often done, that the probability of a particular rainfall or river flow or flood occurring is 1 in X. It is, in fact, more 1 in Y at certain times and 1 in Z at others.

If, however, such behaviour can be perceived, and these two cases are not unique, then there are real possibilities of prediction of trends, and planning to suit these trends.

Construction

In progressive firms the science of management is receiving great attention. Planning of construction work is more detailed and extensive and is also applied with more determination. There is, however, still something to be learned about the conveyance of new ideas to other minds, and occasions can be recalled where it was found impossible to speed up, or even facilitate, a job because somewhere in the system there were men who simply could not change their mental approach to it.

of contractors moved some 12 million tons of earth for drains and irrigation canals, and almost completed 75 road bridges, 25 miles of all-weather and 250 miles of fair-weather roads, to reclaim some 30000 acres of land for rice cultivation, in under 2½ years.

The Diesel engine has achieved a near-monopoly in the civil engineering industry. Steam plant is now uncommon in Britain and, even in pile-driving, Diesel hammers are likely to dominate the future. Mobile or tower cranes are displacing the traditional derrick in all but limited fields, while the reciprocating-piston type of air compressor is giving way to other rotary or screw or free-piston machines.

Hydraulic power

Perhaps the most striking development is in hydraulic torque convertors and hydraulic-powered mechanisms. There are now many devices which can be attached to small and medium tractors with hydraulic generators and enable one man to perform a great variety of operations, such as digging, lifting, pushing, and grabbing. Several of these assemblies can carry out movements similar to those of the human arm—bending, twisting and gripping —and even the small contractor can aspire to such equipment. This should help the very desirable spread of the idea that it is often well worth spending more money to save time.

In rock drilling, the pneumatic air leg, supporting individual, and much lightened, drills, has revolutionized tunnelling, and, when the rock is self-supporting, large tunnels can be advanced at between 200 and 300ft per week, the record being over 500ft. This is also due in part to the availability of microsecond-delay fuses which permit accurate close phasing of an optimum sequence of explosions in blasting.

When tunnelling in soft ground is undertaken, there are now available several ingenious unbolted precast-concrete linings which expedite the work significantly, though the traditional cast-iron bolted segments still have many applications.

The difficulties of handling and storage of cement on sites have been greatly reduced by the use of portable bulk silos and bulk delivery vehicles capable of pumping the cement pneumatically.

International comparison

It may be of interest to make a superficial comparison of British civil engineering with that of other countries. Indeed, anyone whose practice is oversea as well as at home may find it difficult to avoid a multiple split mind, for much that is taken as fundamental in one place is rejected in another. It would, for example, be difficult to persuade many Continental Europeans that massive American dams using natural materials, which American construction plant is designed to handle, are anything but primitive, while Americans are sometimes horrified at what seems to them the expensive refinement and fussiness of European structures.

Britain is proud of her magnificent new motorway M1, but several small European countries have built far more. Even little African Ghana has built more first-class motor trunk roads (Fig. 3) in a decade than Britain did at home in the last three decades. In fact, there are not so many parts of the world left where what is British is assumed to be best.

Britain now has to demonstrate repeatedly that she can do the best work, and much foreign competition is technically very formidable. This is not of itself a bad thing, but lessons learned in the stimulating and often harshly competitive outside world are sometimes only reluctantly accepted by a generally parochial British public. Indeed, someone has said that the employment of a first-class travel agent is an essential prerequisite to a really New Look in Britain.

If it ever does come, it may be assumed that many civil engineers will be delighted that at long last they are able to be as progressive in all and not just in some works, in their own country, as they have had to be of necessity in other countries.

Summary

It may be assumed that the modern British civil engineer is trained and equipped to hold his own in a highly technical world. The degree to which he can actually do so depends, as in all walks of life, on the severity of competition. Much foreign engineering competition is technically redoubtable, and in many parts of the world it is essential to demonstrate continuously that 'British is best', for this is not taken for granted. A significant proportion of the British civil engineering industry is demonstrating that it is best, but it is not a dominant proportion.

Whether we can persuade the British public that it is not necessary to put up with the inadequate because it is familiar or old is another matter, but until we can greatly widen the range and scope of public works in Britain itself, difficulties face us in getting oversea work.

Commonwealth occasion

Mr. F. W. Lawton, Vice-President of the Engineering Institute of Canada (and Oversea Representative of The Institution in Montreal), presents the Duggan Medal and Prize of the E.I.C. to Mr. A. G. Davenport of Bristol University at Savoy Place on the 5th July 1960. Born in India and educated in South Africa, Mr. Davenport took a degree in Mechanical Sciences at Cambridge and did the postgraduate research, for which he won the award, in Toronto

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RESURRECTIONISTS AND FELLOW-TRAVELLERS

Resurrectionists, or body-snatchers, were persons who disturbed the dead in their last resting-places, but in the medical-historical sense they were men who stole bodies for anatomical purposes. The author devotes his remarks chiefly to the latter in this article, which is based on parts (representing only about one-third of the original) of the 15th Annual University Lecture delivered before the North-Western Centre at Manchester on the 1st December 1959. (A report of this meeting appeared in the May 1960 Journal, p. 324.)

Prof. Mitchell is Professor of Anatomy in the University of Manchester.

Prof. G. A. G. MITCHELL, O.B.E., T.D., M.B., CH.M., D.SC., M.SC.

It is probable that the only systematic study of human anatomy in the pre-Christian era was pursued at Alexandria around 300 B.C. During the reigns of the earlier Ptolemies a great school arose and flourished at Alexandria wherein mathematical, biological and other studies were pursued vigorously. The names of two anatomists have come down to us, Herophilus and Erasistratus. Their subjects, however, were not resurrected, but were the bodies of executed criminals.

So far as records reveal, no further human dissections were performed until A.D. 1231. In that year Frederick II decreed that a human body should be anatomized at least once every five years at the medical school at Salerno. Almost a century later, post-mortem examinations were started at Bologna, at first mainly for medico-legal purposes, and gradually the practice became more prevalent and widespread. Human dissections were legalized in Spain and Venice about 1283 and 1308 respectively, and they were allowed in Germany from 1347 and in Naples from 1365.

The anatomy of Vesalius

Executed criminals provided the subjects, and as the study of anatomy was theoretical rather than practical the supply was usually adequate—until the advent of the amazing Vesalius, who studied at the Universities of Louvain, Paris and Padua. He was elected Professor of Anatomy at Padua on the day following his graduation—surely one of the most rapid promotions ever recorded—but he justified the faith placed in him by publishing in 1543, at the age of 27, one of the greatest scientific books of all time, his magnificent and revolutionary 'De humani corporis fabrica', which has been acclaimed by some savants as the first truly scientific work ever produced. Before his day everyone was content with the anatomy of Galen (A.D. 131–200), which was based on the study of animals. That of Vesalius was founded on human dissections, and the supply of bodies was inadequate to feed the flames of his consuming enthusiasm. On more than one occasion when he was a student in Paris he raided gibbets in attempts to secure more material, and his first skeleton, which he regarded as a great prize, was prepared from a body procured in this way.

The medical schools at such centres as Bologna, Paris and Padua were active long before any similar seminaries existed in this country. Anatomy was the principal subject studied, and perhaps this long tradition ensured that the supply of bodies was never so inadequate as it usually was in Britain. Thus, resurrection activities on the Continent were evidently infrequent and disconnected episodes, whereas on this side of the Channel they assumed the form of a horrible trade and culminated in a series of brutal murders. But I am anticipating events!

Recognition in Britain

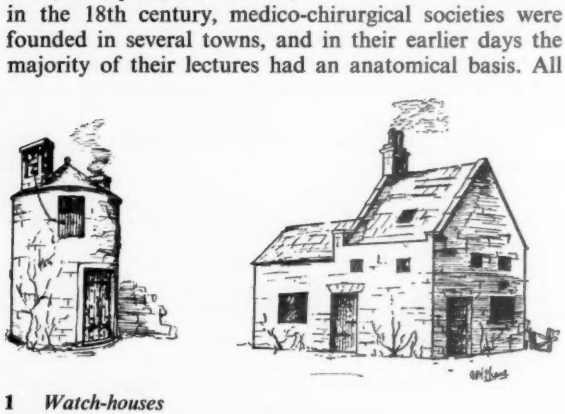
The first university in this country to accord recognition to medicine was Aberdeen. It was founded in 1494, and the Papal Bull of Foundation shows that it was modelled on the famous medieval schools of Paris and Bologna, and this explains why the subject of medicine was included in the course of study. Professorships in medicine were created at Cambridge in 1540, at Oxford in 1546, at Dublin in 1618 and at other universities at later dates. Anatomy was taught in all these schools, but any practical work was usually performed on animals. One Aberdeen professor of medicine petitioned the Privy Council successfully in 1636 for permission to obtain human bodies for dissection, as he had exercised his students sufficiently for two years past in the dissection of beasts.

The barber-surgeons were more active than the universities in providing anatomical instruction. Thus the Guild of Surgeons and Barbers in Edinburgh received a charter in 1505 and it stipulated that before anyone became a freeman and master of the craft he should pass an examination in various subjects, including anatomy. In London the surgeons and barbers united in 1540 to form the United Barber-Surgeons Company, with Thomas Vicary, a surgeon-anatomist, as its first master. Like its Edinburgh counterpart, this association was active in teaching anatomy. It was permitted to have 'the bodyes of ffoure condemned persons yerely for anatomies' and it was granted the exclusive right to conduct anatomical demonstrations. The right to procure the bodies of executed criminals was not always exercised, probably because riots were often provoked when attempts were made to collect the bodies. Friends or relatives often secured the corpses, and sometimes they were stolen by surgeons outside the barber-surgeons'

union, because it is certain that, despite the official ban, private anatomical studies were pursued.

Private schools

In the 18th century, private schools of anatomy were formed, such as those of the brothers Hunter in London and Knox in Edinburgh, sure evidence of the inadequacy of the instruction otherwise available; at later dates similar schools were opened in Dublin, Glasgow, Aberdeen, Liverpool, Manchester, Leeds and elsewhere. Also in the 18th century, medico-chirurgical societies were founded in several towns, and in their earlier days the majority of their lectures had an anatomical basis. All



1 *Watch-houses*

these developments increased enormously the demand for bodies for dissection, and as there was no adequate legal source of supply for the officially recognized teaching institutions, and none at all for the private schools or medical societies, other sources had to be found. In consequence, resurrectionist activities for anatomical purposes became increasingly common in the 18th and early 19th centuries.

As early as 1711 there had been complaints in Edinburgh that graves were being violated and bodies stolen. The surgeons denounced this as 'a scandalous report most maliciously spread about the town'. In 1724, however, an amusing incident again concentrated unfavourable attention on body-snatching when the body of a female, which had been cut down from the gallows by a band of medical students, was forcibly recovered by her relatives; during the fracas the supposed corpse revived, and ever afterwards she was known as 'half-hangit Maggie Dickson'.

Professional body-snatchers

The following year the surgeons issued a pamphlet deprecating and denying resurrectionist allegations—and in practice this meant that greater care and discretion were exercised. At this time the anatomists and their students did the actual stealing, but by the early years of the 19th century the increasing numbers of schools and students had created such a demand that, in larger centres, bands of human ghouls plied a fearful trade as professional body-snatchers. They were never numerous, and even in London in 1828 the full-time professionals did not exceed ten, although there were reputedly about another 200 who on occasion were employed in this kind of work.

The rewards were high, owing to the inadequate supply. We know that Dr. Jordan of Manchester, who had more than he needed for his school, used to supply bodies to Dr. Knox at Edinburgh for £10. In London the average prices were lower, being about four guineas in 1828, but as one small gang had sold 312 corpses during one winter their reward was about £1400, a very large sum in those days and one that men of their type could not possibly have earned legitimately.

The more stringent precautions adopted to prevent body-snatching in the London and Edinburgh areas forced the professional resurrectionists to intensify their nefarious raids in other parts of the country. For example, we learn from the *Manchester Guardian* of the 21st February 1824 about two men who were arrested for being in possession of six recently disinterred bodies; suspicion had been aroused because the men had occupied a stable near Back King Street for several months from which they sallied forth with a gig 'at very untimely hours in the night'. In October 1826, 33 bodies were discovered in the possession of two Liverpool resurrectionists. They were packed in three casks labelled 'bitter salts' intended for shipment to Edinburgh.

Burke and Hare

These recurrent resurrectionist scandals, propaganda by doctors, the remarks of enlightened magistrates, and articles in newspapers and journals focused attention on the problem; and public concern forced a hesitant Government in 1828 to set up a committee to inquire into the study of anatomy. Its deliberations were swept almost to the verge of decisive action by the wave of horror produced by the discovery of the Burke and Hare murders in Edinburgh in November of the same year. Between 1829 and 1831 various measures designed to legalize the provision of bodies for dissection were introduced into Parliament, but it required another murder—this time in London in November 1831—to spur the lackadaisical legislators into line with public opinion, and the following year the Anatomy Bill passed successfully through both Houses and became the Anatomy Act.

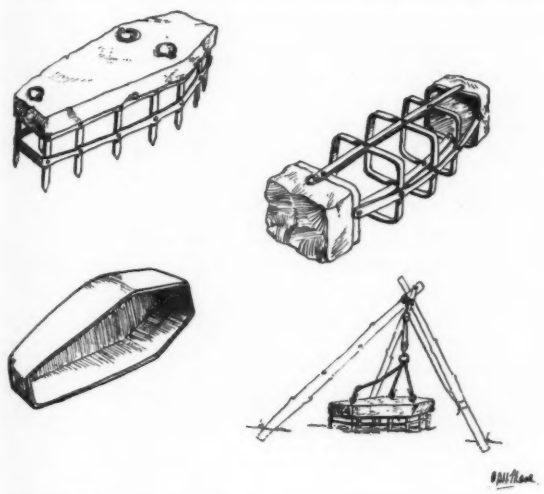
These Edinburgh and London murders which influenced medical teaching so profoundly must be discussed more briefly than their importance merits. Burke and Hare did not resurrect: they murdered. Hare owned a sordid boarding house in Edinburgh, and one of his lodgers, an old pensioner without money, died in 1827 from *natural causes*. This man owed Hare £4, and the latter decided to sell the body to recoup himself. Another lodger, Burke, proved a willing accomplice. A mock funeral was held, the coffin being filled with tanners' bark, and in the evening Burke and Hare carried the body to the University where, on meeting a student in the quadrangle, they asked to be directed to Dr. Monro (the Professor of Anatomy). The student chanced to be a member of

Dr. Knox's extra-mural class and, having discovered their errand, he directed them to go instead to Knox's rooms at 10 Surgeons' Square. They did so, and a porter gave them £7 10s. for the body.

Knox took no part in these or subsequent dealings with Burke and Hare, and he had no idea that subjects reaching his school were not obtained by the usual methods of robbing graves. Nevertheless this chance action by a loyal student was the initial step in the great anatomist's downfall, for the two rogues, having discovered a profitable trade, decided that it could easily be continued by enticing old, defective or friendless people into their den and then smothering them. At least 16 persons were murdered in this manner before the crimes were discovered.

The public horror produced by these crimes was unprecedented. Hare turned King's evidence and escaped the hangman's rope only to be thrown into a lime pit at a later date by fellow-workmen who discovered his identity. As a result he was blinded, but he lived miserably in London for about 40 years thereafter as a beggar. Burke was hanged to the accompaniment of jeers from a vast crowd, and later, in accordance with the judge's sentence, his body was 'publicly dissected and anatomized'.

For years the question of Dr. Knox's complicity was debated, although legal luminaries, after exhaustive inquiries, declared that he was guiltless; and Burke specifically absolved Knox and his assistants from any knowledge, encouragement or connivance in the murders in a written confession made six days before his execution.



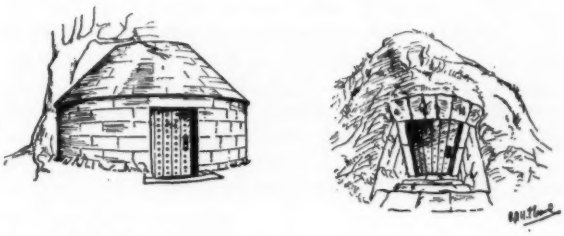
2 *Various types of mortsafe*

Also shown is an improvised sheer-leg tackle used for raising and lowering them

Grave watching

Resurrectionist activities created general fear, and plentiful relics in many churchyards reveal how widespread was the dread of body-snatching. They are numerous in or near some Scottish university towns where anatomy was being actively studied before 1832 and where grave robberies were frequent. The relative absence of such relics in England is surprising, particularly as knowledge of what was happening was not lacking. Thus a Liverpool paper observed:

'The difficulty of obtaining bodies in Scotland, for the anatomical lectures, is chiefly owing to the vigilance



3 *Public vaults*

with which the churchyards are watched. The surgeons are therefore obliged to send their agents to England, where less precaution is generally taken, and the recompense, which is now £10–£15 per body, never fails to procure a sufficient supply.'

The three chief methods adopted to prevent body-snatching were grave watching, the use of mortsafes and the provision of public vaults.

The eerie occupation of grave watching was usually undertaken by male relatives who often carried firearms. Fights between watchers and raiders were common, the latter often being mauled or wounded; and sometimes innocent intruders, such as straying animals, drew the fire of panicky marksmen. Many stories have survived from these days, some genuine and others doubtless apocryphal, of students fooling watchers by transporting their booty in gigs with the dead man propped up between them, or of propelling a corpse like a drunkard supported by two slightly less bibulous companions; of vacant or ruined buildings which were used as temporary hiding-places and which acquired the reputation of being haunted on account of unexplained nocturnal visitations and disturbances; of sextons and undertakers who were easily bribed; and of relatives whose sense of duty evaporated in the amnesic fumes of usquebaugh.

Watching was an uncomfortable business, so in many churchyards watch-houses were built for shelter (Fig. 1). They were often provided with musket holes in the walls, doors or windows; and some had warning bells to summon additional help. Most of those now surviving are used as tool sheds.

Mortsafes

Despite alcoholic and other fortifying agents, grave watching was never popular in those superstitious days, so other methods were devised to protect the dead with less inconvenience to the living. The commonest device

was a mortsafe (Fig. 2), and the simplest type consisted of a heavy slab of stone buried on top of the coffin. Expert resurrectionists soon overcame this obstacle by removing the body through the end or side of the coffin, and they reputedly devised special grappling irons to facilitate their object. To prevent this, an iron lattice-work apron was attached to the underside of the stone slab, or a complete heavy iron cage or coffin-shaped casting was buried around the coffin. In most cases these mortsafes were lifted after several weeks with the aid of a portable sheer-leg tackle, and they could be used repeatedly. In some cemeteries, large, heavy iron cages covering several graves were erected, but unless their bars or walls extended deeply below ground level they did not provide absolute protection.

Public vaults (Fig. 3) were erected in other church-yards, with massive walls, stout roofs and heavy doors—usually double and provided with several enormous locks. The keys were often kept by different persons, and the doors could not be opened unless all the key-holders were present. Bodies were kept in these vaults for weeks before burial, and by then they were useless for dissection.

The passage of the Anatomy Act in 1832 was a relief to all, and not least to the anatomists who had struggled for centuries against prejudice and superstition and who had often pursued their studies in conditions of extreme discomfort and occasional mortal danger. Now their main difficulties were banished, and conditions became much easier for both teachers and students. But we, who are the heirs of this dearly bought inheritance, recall with pride those brave days when the acquisition of anatomical knowledge was a great mental and physical adventure.

Zebra at Winfrith

A NEW zero-energy fast reactor is to be built at the Atomic Energy Establishment, Winfrith, by the United Kingdom Atomic Energy Authority.

Zebra (zero-energy breeder reactor assembly) has been designed for studying the neutron physics of a wide variety of fuel assemblies containing uranium and plutonium. These will be built up by loading fuel elements into a steel matrix (approximately a cube of side 10ft). The fuel elements contain both fuel plates and plates of neutron-absorbing material: the latter will be used to simulate the nuclear properties of the coolant and structure material which would be required in a power reactor.

Zebra will be operated at room temperature and the heat output from the nuclear reactions in the core kept very low so that no cooling system is necessary. It is planned to commission the new reactor during 1962.

From Zebra will be obtained information needed for the design of a prototype which is the next probable step in the development of the fast reactor by the Authority. The work at Winfrith will complement that carried out at the Dounreay Experimental Reactor Establishment.

CROSS-CHANNEL POWER LINK

THE Central Electricity Generating Board have placed a contract valued at approximately £600000 with two British firms for cables to be used for the cross-Channel power link between England and France, connecting the British 275kV Supergrid and the French 225kV network. The contract covers the English shore section and one half of the Channel connection. The remainder will be made by French cable-making companies working on behalf of Électricité de France, and the two cables will be joined in mid-Channel.

Two similar 15-mile lengths of single-core submarine cable, insulated for a nominal 100kV to earth and operating at potentials of +100kV and −100 kV to earth, will be used for the 'go' and 'return' circuits. The link will operate with direct current, and the full load current will be 800amp. The cables themselves will be of the impregnated-paper-insulation solid type; the submarine section will be just over 3in. in diameter and weigh 36lb/yd.

As the cables must be laid close enough to one another to conform with the Minister of Transport's requirement that at all times the magnetic-compass deflection caused by the cables does not exceed two degrees at the sea surface, special techniques have been devised for laying both cables simultaneously.

The Generating Board's 2700-ton collier, m.v. *Dame Caroline Haslett*, has already been used for cable-laying trials, and will be also used for the actual cable-laying operation due to take place in the summer of 1961.

Television for the West Country

THE new Devon and Cornwall stations of the Independent Television Authority will cover areas in which live approximately 1½ million people.

The Devon station, at Stockland Hill between Honiton and Axminster, will serve 861000. The area will be bounded in the east by Weymouth, Shepton Mallet and Weston-super-Mare, and in the west by South Molton, Chulmleigh and Dartmouth.

The Cornwall station will be at Caradon Hill between Bodmin and Tavistock, and it will have 680000 people in its service area. This station is intended to serve the whole of Cornwall, its eastern boundary following a line from Hartland Point through Chulmleigh to Kingsbridge.

Construction work has already started at both stations and it is hoped that programmes will be broadcast by spring 1961.

Stockland Hill will operate on Channel 9 and Caradon Hill on Channel 12, both vertically polarized. This will be the first time Channel 12 has been used in Britain for television transmissions.

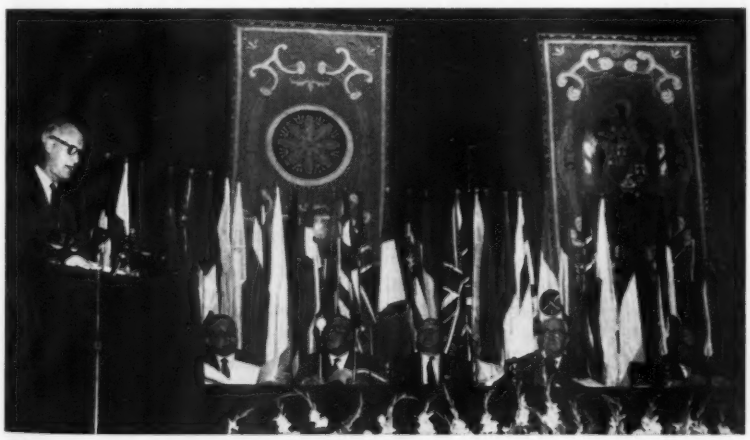
THE SUN AND THE WINDMILL

WORLD POWER CONFERENCE SECTIONAL MEETING, MADRID, 5th—9th JUNE 1960

THE Spanish Minister of Public Works, Sr. D. Jorge Vigón, opened the Sectional Meeting of the World Power Conference in Madrid on Sunday, 5th June 1960 from the rostrum in the Carlos III Theatre. Accompanying him were Sr. D. J. Antonio Suanzes, Chairman of the Spanish National Committee; the Marqués de Casa Oriol, President of the Organizing Committee of the Madrid Sectional Meeting; Gen. Dir. Dipl. Ing. Franz Holzinger, President of the World Power Conference; Sir Vincent de Ferranti, President of the International Executive Council; and other members of the Spanish Government and of the World Power Conference International Executive Council and National Committees.

The sun and the windmill

Behind the long table on the stage were draped the flags of the 51 participating countries, and in front were massed beautiful gladioli and carnations. Around the hall and in the lapels of the delegates were replicas of the emblem chosen by the Spanish National Committee for this meeting—the golden sun shining between two sails of Don Quixote's windmill.



Sir Christopher Hinton speaking at the opening ceremony

In his opening address Sr. Suanzes referred to the theme of the meeting—'Methods of resolving the problems posed by the scarcity of energy'—and reminded us that this theme should make us think of the problem as it affects each country. He remarked that the Conference could be called by tradition and statute 'World Conference for the Peaceful Use of Energy'.

The venerable figure of Sir Harold Hartley, the Honorary Chairman of the International Executive Council, was missing from this opening session, as advancing years have at last begun to curtail his activities. A message from him was read by the International Secretary, Mr. C. H. Gray, in which he mentioned the growing importance of pipelines, a subject on which we were to hear a disproportionate amount by the end of the meeting.

Sir Christopher Hinton, speaking in the name of the British Government and as Vice-Chairman of the British National Committee, ended his speech by reminding us of the statement made by Sir Harold Hartley to the British Association ten years ago: 'On man's use of energy depends so much the future of this troubled world.'

Social affairs

After the inaugural session, the delegates and 'accompanying persons' were welcomed at the Conference premises to a reception by the Spanish National Committee.

The meeting was now well under way, although the technical sessions had not yet begun. Over 2000 people, a record for a Sectional Meeting, had come from the 51 countries; and many old friendships, formed at previous meetings at Vienna, Belgrade, Montreal or elsewhere, were being renewed and new ones formed.

The Conference premises, owned by the National Institute of Industries, had two ample meeting rooms, committee rooms and all the equipment and facilities expected by seasoned world travellers in this decade. A novel feature was the installation of television sets in the lounges and lobbies, making it possible to see at a glance who was contributing to the discussion, and to listen, if the language of the speaker was understood.

Among many receptions, the two most notable were that by the Madrid Corporation in the Retiro Park and the dinner given by the Spanish National Committee in one of the University buildings. At the former, held on the Sunday evening, delegates and their ladies gathered in the Cecilio Rodriguez gardens in the park, which were beautifully floodlit for the occasion. The Madrid Municipal Orchestra was in attendance, and a remarkably fine display of traditional

folk-singing and -dancing was given by girls of the Women's Section of the National Movement.

The dinner given by the Spanish National Committee took place in the premises of the Madrid Law Faculty in the University City. Nearly 2000 people were there, and so fervent were the after-dinner speeches of congratulations made by representatives of National Committees that the flamenco dancing provided for our entertainment had to be sadly curtailed. Singing by a men's choir during dinner was greatly appreciated.

Which source of energy?

One interesting innovation on the technical side of the meeting was the delivery of three lectures by eminent speakers: the first, by M. Georges Combet of France, on 'Natural gas and atomic energy in today's power perspectives'; the second, by Sir Christopher Hinton, on 'The lessons of the past seven years in atomic energy'; and the third, by Dr. Frank K. Pittman of the United States, on 'Present outlook of nuclear energy from the point of view of the United States'. Each lecture in its own way reflected to some extent the national preoccupation of the moment.

All through the meeting, French engineers were bubbling over with enthusiasm at the possibility of laying pipelines across the bed of the Mediterranean and supplying France and Spain with natural gas from the Sahara. One engineer even suggested that it might be piped to the Ruhr, but this was emphatically rebutted by a down-to-earth representative of the German coal-mining community who injected some sound common sense into the debate.

Sir Christopher, in his lecture, gave a candid review of the development of atomic power in Great Britain over the last seven years and illustrated how each country was finding its own solutions to the problems of choosing the right reactor design to meet its own special conditions and requirements. He stressed the need to achieve a higher top temperature in the heat cycle, which, he said, must get nearer to that achieved in conventional stations. He predicted the adoption in Britain of the advanced gas-cooled reactor using graphite as the moderator, as gas cooling gives the best prospects for higher temperatures in the size required.

Britain, he pointed out, is in the fortunate position of having the largest connected load on one single system in the world, and this gave an opportunity to install units of large capacity.

Sir Christopher Hinton's lecture emphasized the dilemma which confronts those who have to decide the size of the nuclear generating programme, a dilemma which has been brought about by the astounding improvements in conventional stations.

Engineers have achieved such remarkable reductions in the capital costs of conventional stations and made such improvements in thermal efficiency that the nuclear stations are finding it harder to compete. This, coupled with the plentiful supplies of coal now available, makes it increasingly difficult to justify spending between two and three times the cost per kilowatt to build a nuclear station compared with a conventional station.

The nuclear-power timetable

Dr. Pittman gave an interesting account of the extent of the United States Government's intervention in the nuclear generating field. Under the 1954 Atomic Energy Act, the U.S. Government is the sole owner of fissile material. It pays a fair price for all fissile materials and will guarantee prices up to seven years to nuclear-power plants. Natural uranium can be purchased from private sources, but the Government purchases any plutonium produced.

The United States are aiming at making nuclear plants economically justifiable if required in any area where coal costs more than 35 cents/million B.Th.U. up to 1968. Improved technology will enable water reactors to compete in the short range in large sizes.

After 1968, the hope is that nuclear plants will be economically justified for installation everywhere, regardless of coal prices. This is based on the assumption that the generating costs of nuclear stations will by then have approached those of coal-fired stations, even where the price of coal is less than 35 cents/million B.Th.U. Dr. Pittman stressed that we must look to systems which will give higher temperatures, higher neutron economy and lower maintenance costs.

The United States are today building a 600 MW conventional power station and are planning an 800 MW conventional station.

Mr. P. Sporn, in summing up the session of which he was chairman, succinctly remarked, regarding the comparisons between nuclear and conventional stations, 'We do not have any adequate information on which to base final conclusions'. He also made some frank comments on his own supercritical high-temperature station and said that they were having to decrease the temperature by 50° F. What was wanted, he said, was a metallurgical breakthrough.

At another session it was interesting to learn that the British Central Electricity Generating Board have invited tenders for two generating sets to operate at 3500 lb/in.^{2} and 1100° F.

The provision of coal-fired superheaters to give higher temperatures in nuclear stations was advocated by several speakers. The remarkable achievement of the engineers of the British Gas Council in developing successfully the *Methane Pioneer*, the ocean liner for importing liquid methane, was highly commended.

In spite of the promise of nuclear power, the discoveries of new supplies of oil and natural gas, and the confidence of the oil producers in the near-inexhaustibility of this source of energy, there seemed to be a growing feeling towards the end of the meeting that the fuel which has made possible the civilization which we know today had been almost overlooked. Coal-mining is inevitably an inflexible industry, and the coal reserves and the mining communities have to be carefully nurtured if they are to be readily available to meet scarcities in world energy supplies in the future, a possibility which few would deny.

The sun and the windmill. Adventurous spirits will forever tilt at the windmills, but they will be carried along for many years yet on the back of coal, like Don Quixote on his faithful steed, Rosinante. In this way does civilization progress.

B. L. METCALF

An electrical engineering review

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THE APPLICATION OF AUTO-RECLOSERS

The use of overhead distribution networks introduces hazards to the continuity of supply to consumers in rural areas: most of these hazards are of a transient nature. It is essential to avoid unnecessary interruptions to the supply, and the installation of auto-reclosers can reduce the number of interruptions by 90%. The author of this article is Chief Engineer of the Midlands Electricity Board.

G. S. BUCKINGHAM, B.SC.(ENG.), MEMBER

THE reliability of the public supply of electricity is obviously as important to consumers in rural areas as to those in urban areas. The overhead-line construction of distribution networks in rural areas, however, introduces certain risks of interruption to their supply. It has been found from experience that most of these are of a transient nature—caused by straws or twigs blown across conductors by the wind, large birds, or stormy weather, particularly lightning. A flash of lightning may cause dozens of high-voltage fuses to blow and interrupt supplies for many hours over large areas when, in fact, no permanent damage has been done to the distribution system.

Distribution engineers over the years have exercised their skill in attempts to overcome this problem by the design of self-resetting fuses, weight-operated reclosing switches, the use of arc-suppression coils and, most recently, the introduction of high-speed auto-reclosing circuit-breakers.

The function of the auto-recloser is to de-energize a line immediately a heavy fault current flows either to earth or between phases. If this is done quickly, the wisp of straw or whatever caused the short-circuit will burn up, and in another second the supply can be restored without damage being done. If the flashover is due to lightning, the power arc which normally follows is extinguished by the auto-recloser—the one-second delay allows the ionized air in the neighbourhood of the flashover to dissipate—and the supply can be switched in again.

The high-speed interruption of power arcs following a flashover has the additional beneficial effect of reducing the permanent damage done by such arcs to line and bushing insulators, conductors and other equipment, and this is a further contribution to the reliability of a supply fed from overhead lines.

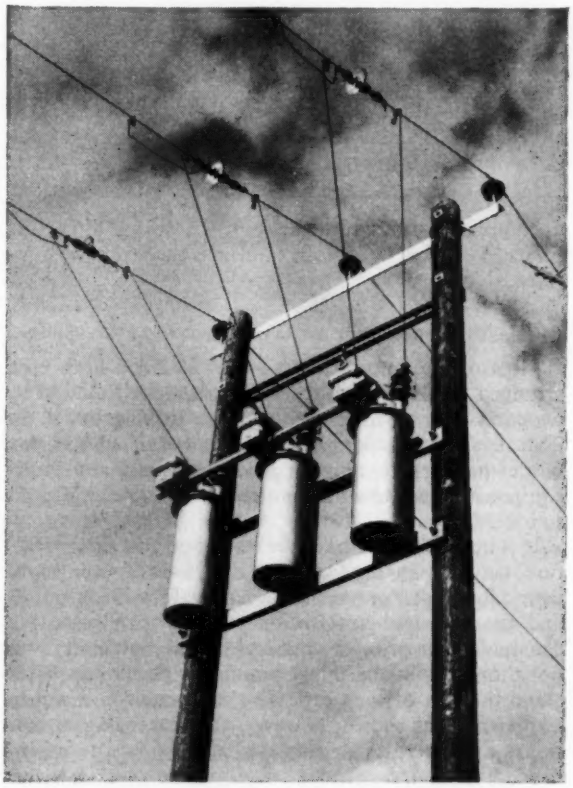
Method of operation

The auto-reclosers until recently in general use are single-phase units mounted on poles in pairs for single-phase lines or in groups of three for 3-phase lines. They are supplied in a range of ratings. The passage of a fault current of anything over twice the normal rating operates a series coil which opens the circuit and charges a reclosing spring.

The sequence of opening and reclosing with predeterminable time intervals depends on what happens at the site of the fault. In the case of a transient fault, the auto-recloser clears the trouble in one or two instantaneous shots and then after an interval resets itself. If it really is a permanent fault, the auto-recloser goes through a sequence of two further time-delayed operations and then locks out—i.e. the supply is finally interrupted until the fault is repaired.

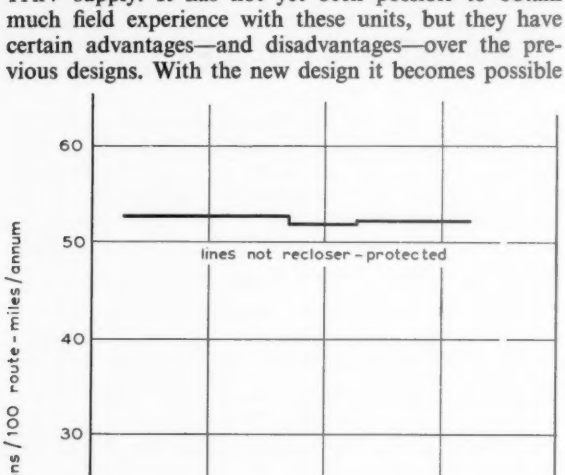
In the event of any transient fault, the units operate singly, but, if one of them finally locks out, the remainder in the single-phase or 3-phase group are all locked out together by means of a mechanical coupling rod (Fig. 1).

A newer design of auto-recloser is a 3-phase unit in



1 *Three single-phase auto-reclosers mechanically coupled*

one tank. It is operated by means of a spring charged by the use of a shunt solenoid connected across the main 11kV supply. It has not yet been possible to obtain much field experience with these units, but they have certain advantages—and disadvantages—over the previous designs. With the new design it becomes possible



2 *Operational experience on 11kV lines protected by auto-reclosers*

to mount current transformers in the switch tank, and simple earth-leakage protection can therefore be provided along the lines.

Application

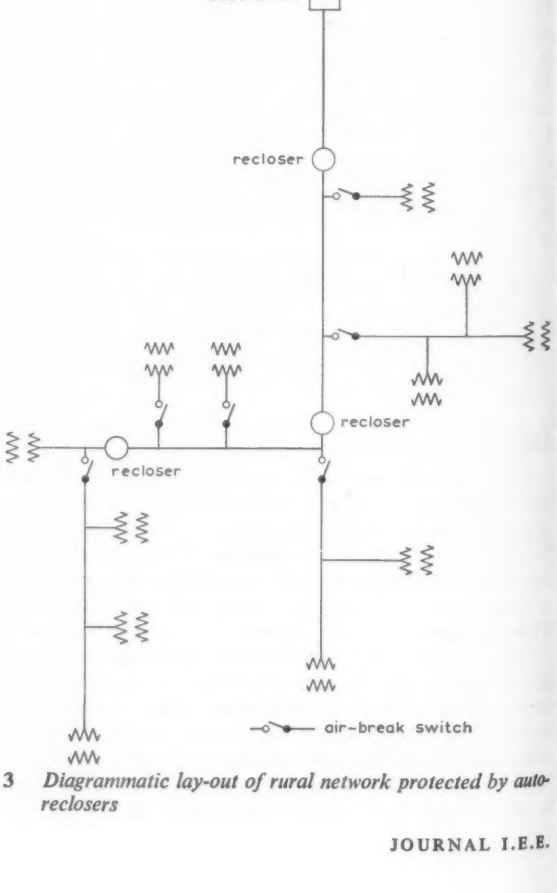
Most of the auto-reclosers so far installed have been arranged with two high-speed interruptions followed by two time-delayed interruptions, then locking out if the fault persists. This permits fuses on any faulted branches of the network to blow and so disconnect any faulty equipment and allow the auto-recloser to re-energize the sound network.

It is quite difficult, however, to get correct discrimination between an auto-recloser and a fuse, even slow-acting fuses such as have been designed for this purpose, and the principal justification for this arrangement is economic. The price of auto-reclosers is high, and it was not thought that the thinly populated rural areas could stand the cost of such expensive equipment in quantity. Experience has shown, however, that the saving in man-hours and in revenue does in fact justify the capital expenditure, and greater numbers of reclosers are therefore being installed.

Fig. 2 indicates the operating experience obtained with automatic circuit-reclosers in the Midlands Electricity Board's area over the period 1st April 1956 to 31st March 1959, from which it will be seen that approximately 90% of the faults on rural h.v. systems have been eliminated by their use. One feature which has emerged from these statistics is the very small number of fuse operations, since the high speed of the instantaneous trips prevents transient faults from developing into persistent ones.

It is considered that on new systems the provision of fuses may be omitted and the time-delayed trip of the recloser is not required for co-ordination purposes. A modification to the recloser mechanism has therefore been introduced to provide two, three or four instantaneous tripping operations for protection against transient faults—the rare persistent fault causing lock-out as before. This use of instantaneous tripping operations permits better discrimination with back-up protection and, by selecting the number of operations before lock-out, provides a ready means of discrimination between reclosers in series (Fig. 3).

In this way the most remote auto-recloser faced with a persistent fault will reclose twice and then lock out while the back-up reclosers still have one or two shots in the locker and will leave the supply intact up to the



3 *Diagrammatic lay-out of rural network protected by auto-reclosers*

most remote section. By making all the operations instantaneous, it is hoped to increase the short-circuit ratings of all sizes of auto-recloser. It still remains, however, to provide means of isolation for branch circuits.

The overload protection at a main substation has had to take account of the time taken by the sequence of tripping operations of the auto-recloser on the line, and it has been customary to set the time of back-up relays to approximately twice the delayed trip time of the recloser to avoid maloperation. The use of the all-instantaneous trip-operating sequence will greatly facilitate the grading of reclosers and back-up protection.

Earth-fault protection

With the auto-reclosers used hitherto, the protection against high-resistance earth faults has had to be provided at the main substation. In unfavourable circumstances, the earth-fault current may be very low indeed, and relays for earth-fault protection on rural feeders must therefore be sufficiently sensitive to detect such low currents and at the same time sufficiently robust to withstand the thermal effect of much heavier short-circuit fault currents.

One approach to this problem is to make use of a sensitive polarized moving-iron relay rectifier fed from a specially designed core-balance current transformer. This current transformer has a Mumetal core and its ratio is independent of circuit load or fault-current rating. A time-delay relay is necessary to enable grading with other relays to be provided.

Since a core-balance current transformer is not required to provide the magnetizing current of other current transformers in idle shunt, this form of protection is extremely sensitive, a primary earth-fault current of 1amp being sufficient to cause operation. Nevertheless, a through-phase-fault stability factor of over 2000 is claimed.

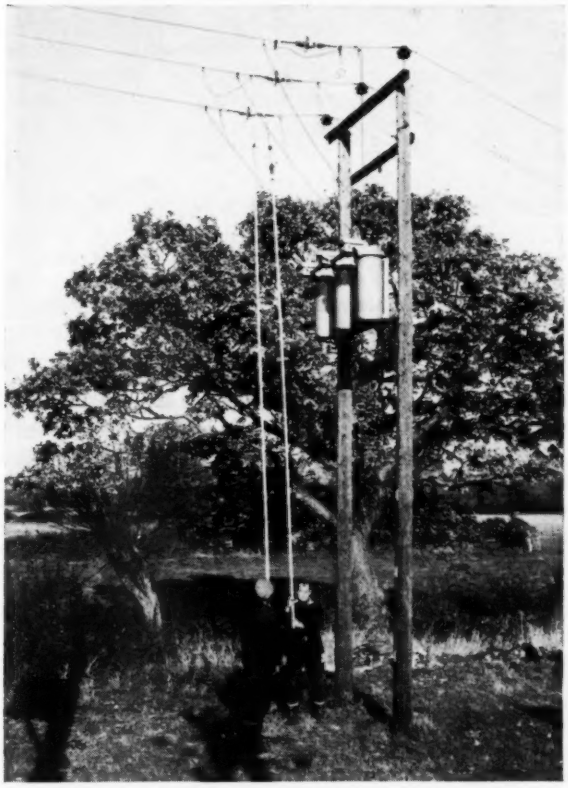
It remains to be discovered from experience in the field whether such extreme sensitivities to high-resistance earth faults may not cause more trouble than they save. It is known that, in adverse weather conditions, surge-leakage currents of several milliamperes per insulator are not unusual, particularly in situations subject to some industrial pollution of the atmosphere. It is therefore quite possible to find leakage currents of the order of 5amp flowing to earth on long overhead-line feeders. On the other hand, a broken conductor falling on to dry ground or a hedge on a dry summer day may result in no greater earth-leakage current flowing.

A solution to this problem may be the greater use in future of 11kV overhead-line insulators with a conducting glaze having a leakage current of about 1mA per insulator. The heat generated in the conducting glaze tends to keep the insulator dry and thus prevent high earth-leakage currents caused by surface moisture.

The newer designs of auto-recloser can be provided with sensitive earth-leakage protection at the recloser, and it is hoped that this will overcome some of the problems associated with high-resistance earth faults on rural lines.

Maintenance

Switchgear in main substations is inspected immediately after any severe fault, and is probably completely serviced after fewer than half-a-dozen operations on faults. With auto-reclosers it is impossible to provide



4 *Auto-recloser being removed for maintenance, using live-line working technique*

such maintenance, and the present system is to remove them from site to workshops for a complete overhaul after either 100 operations or two years' service, whichever is the less. So far this has been satisfactory, and it may be possible to extend the period, particularly in areas where the short-circuit levels are low.

In future installations it will not be necessary to cause interruption to the supply of rural areas for the removal and replacement of auto-reclosers under maintenance, since complete changeovers can now be made in live-line conditions (Fig. 4).

Future developments

The principle of high-speed auto-reclosing has brought the incidence of interruptions on rural networks close to the experience of urban networks with underground

cables. It must be the ambition of distribution engineers to improve on this. Experience is likely to lead to the elimination of more fuses on overhead lines, while retaining the ability to sectionalize branch circuits quickly.

High-speed auto-reclosing has so far been limited in this country to 11 kV lines, but the development of higher-voltage equipments suitable for use on overhead lines or in unattended substations will not be long delayed. It will then be necessary to consider even more closely the contending demands of safety and continuity of supply. It will become even more urgent to have available reliable systems of sensitive earth-leakage protection at the maximum number of positions.

Auto-reclosers are not yet available with short-circuit ratings over 75 MVA. It follows that if the short-circuit level at the main substation is 150 MVA—and it may be 250 MVA in some cases—it has not hitherto been safe to install auto-reclosers nearer than some miles from the main substation, i.e. where the short-circuit level will have fallen to 75 MVA or less.

This leaves those few miles of line without the benefit of the protection of high-speed auto-reclosers. There are two ways of overcoming this difficulty: first, to design auto-reclosers with a higher safe short-circuit level, and secondly, to design and introduce high-speed reclosing circuit-breakers in main substations. This will involve greater maintenance problems when greater fault currents than are experienced on auto-reclosers at present have to be interrupted and switches reclosed several times in quick succession. The safety of underground-cable connections subjected to repeated short-circuits will also require careful consideration.

Summary

Experience in the use of high-speed auto-reclosers is resulting in greater benefits than were originally anticipated. Designs are being improved in the light of experience, with consequential improvements in continuity of supply, economy of working and safety. It is to be expected that the increasing use of these equipments and their operation at higher voltages will make the reliability of the electricity supply to the rural consumer equal to that to the town dweller.

COUNCIL MEETING ON THE 21st JULY 1960

THE following summary of reports received and decisions reached by the Council of The Institution at their meeting on the 21st July 1960 is issued on the authority of the President in a form approved by the Council. It will be understood that this report does not purport to be a complete account of the matters discussed at the meeting, as some items are to be the subject of further discussion by the Council.

Specialized Sections

The Council considered the adequacy of the present alignment of specializations within The Institution in the light of a report prepared by the General Purposes Committee, who in March 1959 had set up a Panel to examine this question. In the view of the Council, the matter merited further investigation, and the General Purposes Committee were asked to pursue their proposed line of inquiry with a view to reporting to the Council again in the near future.

Institution Summer Meeting, 1961

On the recommendation of the General Purposes Committee, the Council agreed that the most suitable form of Institution summer function for 1961, a year in which there would be no Conversazione, would be a meeting based on London. This would give an opportunity to members both to celebrate the completion of the reconstruction of the building at Savoy Place and to visit many places of technical interest in and around London. It was noted that this meeting would probably take place early in June 1961.

Examination Regulations

The Council received the report of a Panel, set up by the General Purposes Committee in association with the Education and Training Committee, the Examinations Committee and the Membership Committee, which was introduced by Sir Josiah Eccles, Chairman of the Panel.

The report was divided into two parts, the first containing recommendations for a new channel of entry to Corporate membership* for those whose professional responsibility measures up to the required standard but who, for one reason or another, have encountered difficulty in satisfying the Part III Examination requirement. These recommendations were approved, together with a statement, prepared by the Examinations Committee, describing the new rules† for entry by means of a thesis, report or technical essay.

One of the recommendations concerned the extension of Student membership in certain cases beyond the age of 28, and the question of eligibility of such Students for office in Graduate and Student Sections was referred by the Council to the General Purposes Committee.

Electrical technicians

The second part of the Panel's report dealt with technical associations and ways and means of encouraging and assisting the very wide range of people for whom they catered. The lines of approach suggested received the Council's support and were referred to the General Purposes Committee for further consideration.

The Council recorded their appreciation of the extremely hard work put in by members of the Panel.

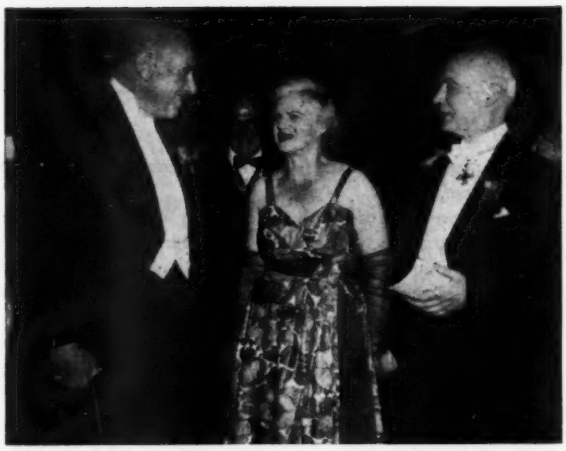
Building reconstruction

The Council gave authority for the signing and sealing of an agreement with Mr. R. M. Phillips, the owner of Savoy Hill House, with reference to the maintenance of the boundary between that property and The Institution's private road.

* Further information will be given in a subsequent issue of the *Journal*

† The details are given in a supplement to the Examination Regulations, obtainable on application to the Secretary

(left to right) *The President, Lady MacLaren, Lady Jackson and the President-Elect*



(left to right) *Lord Chandos, Mrs. C. T. Melling and Mr. C. T. Melling*

CONVERSAZIONE

PERHAPS the Institution Conversazione at London's Royal Festival Hall on the 23rd June 1960 would not compare itself with the 'Phenomenon of the Age', advertised to appear at the same place on the following Sunday, but as a social phenomenon it was as well patronized and enjoyable as ever.

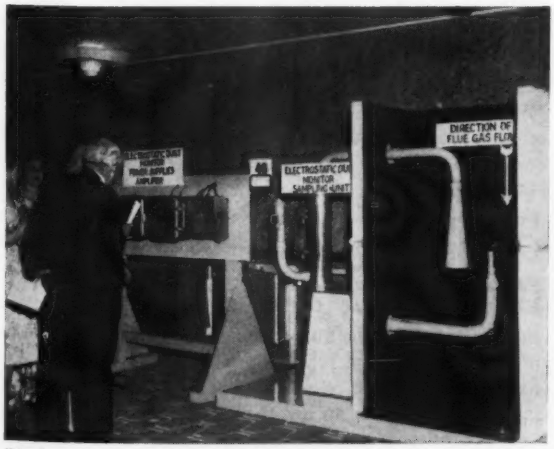
About 2000 members and guests were received by the President, Sir Willis Jackson, and Lady Jackson, assisted by the President-Elect, Sir Hamish D. MacLaren, and Lady MacLaren and members of the Council.

The point of the occasion is that one can wander in complete freedom over the six levels of the hall, led by fancy, by a thirst for technical knowledge, by a love of music or dancing, or by just plain hunger or thirst.

From the 70-odd exhibits and demonstrations, one recalls a model of an electrostatic dust monitor, a human-reaction timer, an automatic trolley, a floor-warming display, a miniature television-studio set, an electron microscope and image intensifier, and a recording of a voice from outer space (a transmission to the United States via the moon).

But others found equal interest in such matters as a transistor electrocardiograph, the synthesis of sound waves, levitation using a colour reference oscillator, the procedure of stand-off bombing, a model of a steel rolling-mill, and a letter-mail address-coding desk.

For lighter fancies, there were two 40-minute concerts in the auditorium, with the orchestra of the Corps of Royal Engineers and the Linden Singers; and dancing in the foyer from 8.30 p.m. to midnight.



Display of an electrostatic dust monitor for smoke- or dust-laden gas

Demonstration of a storage-tube device, 'freezing' one frame of a television picture

CORRESPONDENCE

INSTITUTION PUBLICATION PROCEDURES

I FEEL I must endorse Mr. Humphrey's remarks in the June 1960 *Journal*, p. 368.

In my own case, the problem of space for the *Proceedings* has baffled me, and I now resort to the 'dismemberment' method referred to by Mr. Humphrey. This is not uncommon apparently, since several of my colleagues are also reduced to disposing of their copies this way.

It seems to be inevitable, unless your job merits a large personal office with authority to order cabinets *ad lib.* at firm's expense.

Mr. Humphrey's constructive suggestion would seem to solve the problem, and I hope something on these lines can be evolved and put into operation as soon as possible.

R. J. CARRIER, ASSOCIATE MEMBER

35 Rushy Lane
2nd July 1960 Sandiacre, Nottingham

I WHOLE-HEARTEDLY support Mr. Humphrey's suggestion in the June *Journal* that The Institution should publish all its papers separately; I have entirely given up taking the *Proceedings* because I had to take so large a proportion of unwanted material. I suggest that all who have views either way should express them to the Editor of the *Journal* or to The Institution direct.

R. A. LAWS, B.SC., ASSOCIATE MEMBER

Clifton Lodge
39 Park Road
6th July 1960 Watford, Herts.

MR. Humphrey's suggestions in the June *Journal* for simplifying The Institution's publication procedures deserve widespread support, especially from those members who think that it is better to cut costs than to raise subscriptions. There is no doubt that there would be a rapid decrease in paper consumption if members were obliged to ask for papers which they wished to read. One difficulty which has to be faced is that the number of copies to be printed could not be correctly determined beforehand, whereas at present the number of subscribers to each Part of the *Proceedings* is known. However, if the particulars of each paper were published one month before they were due for printing, there would be time for most of the order cards to come in.

Furthermore, the *Proceedings* should follow the lead of *Science Abstracts* and change over to the offset lithography printing process using typed originals. Cheaper, faster printing would result. It is true that nothing can quite match the elegance of good letterpress printing on high-quality paper, but we are engineers, not art critics.

If any member thinks Mr. Humphrey's suggestions are too drastic, it may help to point out that 40 years ago Sir James Swinburne was writing that 'one can go farther and rely entirely on *Science Abstracts* and *Engineering Abstracts*, and stop all technical papers, and all societies' journals that can be stopped. This may be very bad advice to a young man, and it ought to mean increasing ignorance and stagnation; but it does mean much happiness.'

SELWYN PALMER, B.SC.(ENG.), ASSOCIATE MEMBER

31 Drumsheugh Gardens
14th July 1960 Edinburgh 3

I SHOULD like to say that I agree whole-heartedly with the letter written by Mr. W. E. Humphrey, published in the June *Journal*.

The scheme put forward by him is precisely the one which I have often thought would be extremely suitable for publication of the Institution *Proceedings*, and I for one would like to see it adopted.

R. A. STEVENS, M.SC.(ENG.), ASSOCIATE MEMBER

65 Dan-y-Graig
14th July 1960 Whitchurch, Cardiff

I READ with great interest Mr. Humphrey's letter in the June *Journal* and realized immediately that he had expressed in words what has been in my mind and in those of many professional acquaintances and colleagues for some considerable time.

As he pointed out, we perhaps all feel that the system of the *Proceedings* publishing method is 'hallowed by tradition', and our minds stopped short of devising a new system. Mr. Humphrey is to be congratulated on his well-thought-out extension of the present monograph system to cover all published papers, and I feel there must be many members who will agree with me when I say that it will be definitely worth the small inconvenience of ordering the papers that interest them rather than accumulate files of torn-out pages, or bulky copies of unwanted *Proceedings*, either rolled or unrolled!

Personally, I cannot suggest any practicable improvements on Mr. Humphrey's suggestions, and I look forward with interest to any future steps in this matter which may be taken by the Council.

R. P. MYBURGH, B.SC.(ENG.), ASSOCIATE MEMBER

c/o Electricity Supply Commission
P.O. Box 117
15th July 1960 Cape Town, South Africa

SUPPLY SECTION DISCUSSION ON 'AN ELECTROSTATIC DUST MONITOR'

IN the account of the above discussion given in the Bulletin of the Sections, June 1960 *Journal*, p. 387, I am reported as having said that the power stations of this country 'poured into the atmosphere no less than five million tons of dust a year'.

My statement was that the power stations *produce* some five million tons of dust a year, and that the collection of this

dust and the monitoring of any dust emission which escapes the collecting plant is a major problem, and one of considerable economic importance.

Most of this dust is, of course, removed from the flue gases by cyclones or electrostatic precipitators. A modern, well maintained dust-collecting plant will remove over 99% of the dust from the gas, and efficiencies of 99·3% are now specified for large stations.

J. S. FORREST, D.SC., M.A., MEMBER
Central Electricity Research Laboratories
Kingston Road
Leatherhead
8th July 1960 Surrey

A CHALLENGING MEDIUM

MY good friend B.G.P. has done me proud in the June 1960 *Journal*, p. 388, where he has written up under the title of 'A challenging medium' my lecture before the Electronics and Communications Section on the 23rd March 1960. But in one respect he has also done me a serious injustice, and I seek your help in defending myself against a possible charge of misstatement and even of ignorance by your readers.

The figure that I actually quoted for the radiated power from a transmitter at the North Pole in order to obtain a field strength of 1 μV/m at the Equator was 10^{750} kW, and this was in the absence not only of the ionosphere but also of the troposphere and for a smooth earth. The fact that your published figure is 10^{700} kW is neither here nor there, for what is a factor of 10^{50} (a mere 500 decibels) in so many? In any case, as was pointed out to me by an engineering friend, there would be a corona discharge if one attempted to use such powers.

However, B.G.P. makes no reference to the fact that I qualified my statement by saying that it referred to a half-wave vertical dipole on the surface of the earth for a wavelength of 1 metre. I would assure your readers that I am frequency-conscious; and, as the C.C.I.R. ground-wave curves show, which also ignore the ionosphere, on a frequency of 10 kc/s one could get away with a mere 10^6 kW. The main difficulty here, of course, would be the building of a half-wave dipole, and one might have to content oneself with a more modest aerial of small radiation efficiency and make up the difference by increasing the input power.

As this is all hypothetical, since the ionosphere does exist, perhaps no great harm has been done, but I am sure you will agree that as a matter of principle my honour should be vindicated.

G. MILLINGTON, M.A., B.SC., MEMBER
17 Chelmerton Avenue
4th July 1960 Chelmsford, Essex

[Dr. B. G. Pressey writes: I am sorry to learn that, in my endeavours to summarize Mr. Millington's very informative lecture, I should have given your readers cause to suppose that he was frequency-unconscious. I am sure that his reputation as a propagation engineer is too high for them to entertain such a thought for one moment!

This unfortunate omission has, however, led Mr. Millington to give further data which I am sure will be of great comfort to any engineer who may ever be confronted with the task of providing communication over the surface of a smooth, ionosphereless and troposphereless earth.]

ELECTRICAL NOISE

WHILE I entirely agree that some parts of my book may be considered controversial, I must take issue with your reviewer's penultimate paragraph in the May 1960 *Journal*, p. 312, which is a complete misunderstanding and almost a misquotation of what I wrote.

I did not say that a current in a wire *resembles* a displacement current. I explained with great care that electric current, properly defined, is continuous; and therefore the current in the wire connecting two plates, which is a conduction current, must in order to satisfy continuity be *equal* to the displacement current in the dielectric between the moving charge and one of the plates. His statement that 'a displacement current sets up a potential difference growing with time' is in general untrue. It is true only of a displacement current, as of any other current, if that current flows into a constant capacitance which is free from conductance.

Your reviewer has indeed confirmed my belief that a careful study of the specification of 'electric current' is essential before one proceeds to study fluctuations of electric current.

D. A. BELL, M.A., B.SC., PH.D., MEMBER
Birchcroft
506 Groveley Lane
18th June 1960 Rednal, Birmingham

[Our reviewer (Dr. C. S. Bull) writes: I have no wish to belittle the value of Dr. Bell's book by entering into detailed discussion of any of the controversial points which it may contain. However, I feel bound to reply to the statements he makes in his letter.

The word 'resembles' was used to summarize a sentence on p. 9, commencing 'The conducting part of the circuit will behave very much like a polarizable dielectric, etc. . . .', and I think there can be hardly much doubt as to the meaning conveyed.

Dr. Bell's remark that a displacement current does not in general build up a potential difference which grows with time is not well founded. The strength of a radio wave is expressed in volts per metre, and the peak values of this quantity are built up by the displacement current in the wave during each half-cycle.

A displacement current *in* the dielectric of a capacitor was postulated by Maxwell to give continuity to the current in a general circuit consisting of capacitors and wire. The p.d. built up by the displacement current in this case is bounded by the plates of the capacitor, but the elements of it exist across elements of the dielectric. A displacement current cannot flow *into* a capacitor as Dr. Bell suggests.

Dr. Bell is correct in believing that an understanding of the electric current is necessary. In his book, in the sentence prior to that quoted above, he states 'Since this (charge) $+e$ is shared between the cathode and anode, we are considering charges of magnitude less than that of the electron charge e, but this is not an insuperable difficulty'. Since no charge smaller than the electron has yet been found, it could legitimately be doubted if a proper understanding could be obtained on the lines he suggests.]

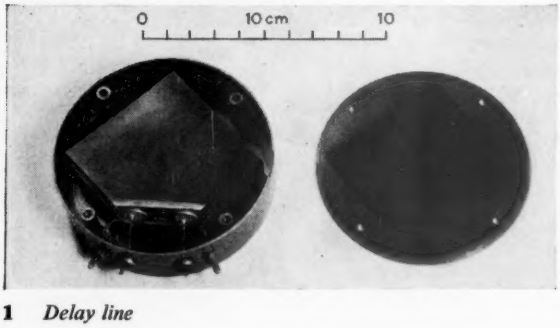
HENRI DE FRANCE COLOUR-TELEVISION SYSTEM

A short article based on an Electronics and Communications Section paper (3251) with the above title by R. Chaste, Ing.É.S.É., L. ès Sc., and P. Cassagne, Ing.É.N.S.T., L. ès Sc. The paper was published individually in April 1960 and will be republished in Part B of the Proceedings. It was read before the Electronics and Communications Section on the 27th April 1960 at Savoy Place (see p. 514).* *M. Chaste is with the Compagnie Télégraphie Sans Fil and M. Cassagne with the Compagnie Française de Télévision.*

It is well known that colour television is based on the trichromatic theory of colour perception, which is why three electrical signals are necessary to reproduce a coloured picture electronically. At the transmitting point, the picture is analysed through three filters, red, green and blue respectively, from which, by means of analysers, three electrical signals E_R, E_G and E_B can be derived.

Luminance and chrominance

One of the most important factors in colour television is the need for compatibility, and this has imposed some restrictions on the development of systems for broadcasting.



1 *Delay line*

For each compatible system, therefore, the colour picture is not defined by the three signals (E_R, E_G, E_B) obtained from the analysers. From them is built first a signal absolutely identical to that which would be given by a black-and-white analyser; this is the luminance signal E_Y, which must be transmitted over a large bandwidth. Secondly, the three primary signals are combined in a fairly simple way to provide two chrominance signals, E_{C1} and E_{C2}.

It can be said that the chrominance signals supply the colour of the picture drawn by the luminance signal. There is less need for definition of colour than of outline, because the eye cannot discern the colour of picture details. The chrominance signals can, therefore, be transmitted over a small bandwidth.

Two-way compatibility is ensured by the particular choice of the three transmitted signals. A black-and-white receiver can accept only the luminance signal, and so gives a black-and-white picture when receiving a colour-television programme. Conversely, a colour receiver fed by a black-and-white television signal will produce a black-and-white picture.

Sequential transmission of chrominance

In both the N.T.S.C. and the Henri de France colour-television systems, chrominance signals modulate a subcarrier whose frequency is at the end of the video spectrum, but the methods of effecting the modulation are different.

In the N.T.S.C. system, the two chrominance signals modulate the subcarrier simultaneously in amplitude and in phase. In the Henri de France system, the two chrominance signals alternately modulate the subcarrier, the rhythm of change being the line frequency. At every moment, modulation is of a single type, not yet finally chosen.

This sequential transmission of chrominance information is perfectly logical, because, as mentioned above, the eye does not discern the colour of picture details, and the amount of chrominance information necessary can be much less than the luminance. The chrominance information can be reduced in the horizontal direction by reducing the bandwidth of the chrominance signals (see above), and this technique is used in both the N.T.S.C. and the Henri de France systems.

However, with the information reduced in the horizontal direction, it is unnecessary to supply the full signal in the vertical, and it is sufficient to renew the chrominance information every other line only. This harmonization of horizontal and vertical definition is achieved only in the Henri de France system.

Transmission of two signals only

This rational manner of treating chrominance information provides some kind of reward. Two signals only are to be transmitted simultaneously, instead of three, giving greater ease of transmission. The two signals transmitted at every moment are the luminance signal and one of the two chrominance signals.

Owing to the method of transmitting the three original signals, the Henri de France receivers have some novel features. The three original signals must be found again, although two of them only are received at any time. A delay line providing a delay of one-line duration is used to obtain

* This article and those following are based on, and written by the authors of, current Institution papers. The authors have been asked to make these articles so far as possible interesting and of appeal to electrical engineers who have no specialized knowledge of the topics, and the content of the articles is not necessarily confined to the subject-matter of the original papers

three simultaneous signals from three non-simultaneous ones. This delay line (Fig. 1) enables one to have at each instant the luminance signal, the only chrominance signal actually transmitted, and the chrominance signal transmitted during the preceding line.

Ease of transmission

Generally speaking, for compatible colour-television systems, it is necessary to transmit the luminance signal and a subcarrier modulated by the chrominance signals. Non-linearity of transmitters, receivers and radio links is very bad for this set of signals. In particular, it causes parasitic modulation of the subcarrier by the luminance signal and then a change of colour. Non-linearity of equipments is characterized by two parameters, the differential gain and the differential phase. The differential gain expresses the parasitic variations of subcarrier amplitude due to the luminance signal; the differential phase is related to changes of subcarrier phase due to the same causes.

Very close tolerances for differential gain and differential phase are imperative for the N.T.S.C. system, but not for the Henri de France system. This can be easily understood by considering the single type of subcarrier modulation used. For example, if amplitude modulation is used, parasitic changes of the subcarrier phase have no effect on the chrominance of the picture.

This ease of transmission of the Henri de France pictures has been demonstrated on the French radio links several times. Closed-loop transmissions have been made successfully over distances as great as 800 miles. The radio links used were those originally built for black-and-white television pictures, and for this reason they were unadapted for N.T.S.C. pictures.

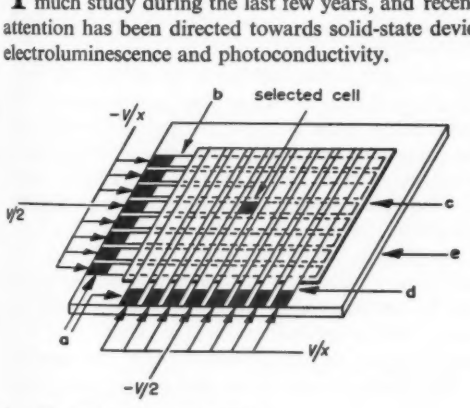
At present, most countries have networks of radio links for black-and-white television. The possibility of using these for colour television is a very important point to be considered when thinking of the future of colour television. The Henri de France system may provide a solution.

621.397.132

ELECTROLUMINESCENT STORAGE

A short article based on a Measurement and Control Section paper (3217) entitled 'High-speed light output signals from electroluminescent storage systems' by G. R. Hoffman, Ph.D., B.Sc., D. H. Smith, M.Sc., Ph.D., Associate Member, and D. C. Jeffreys, M.Sc., Graduate. It was published individually in February 1960 and will be republished in Part B of the Proceedings. It was read at Savoy Place on the 1st March 1960 before the Measurement and Control Section (a report appears on p. 515). The authors are in the Electrical Engineering Laboratories, Manchester University.

THE problem of digital-information storage has received much study during the last few years, and recently some attention has been directed towards solid-state devices using electroluminescence and photoconductivity.



1 *Electroluminescent matrix*
a silver contact 'flag'
b transparent gold bars (*y* conductors)
c phosphor layer
d copper bars (*x* conductors)
e glass

The property of electroluminescence may be used very simply in a permanent type of storage system, for example to read punched cards with an electroluminescent matrix panel as shown in Fig. 1. This matrix consists of a layer of electroluminescent material sandwiched between two orthogonal sets of conducting lines.

If a voltage pulse is connected to one of the x co-ordinate conductors, and another to one of the y co-ordinate conductors ($x = \infty$), a light pulse will occur at the intersection of these two lines. A mask may then be placed between the matrix, and a photomultiplier used to detect the light pulses, so that a '1' can be indicated by a hole and a '0' by no hole in the mask. The matrices for use in this system may be small, for example with a line width of 10 mils and a spacing of 5 mils.

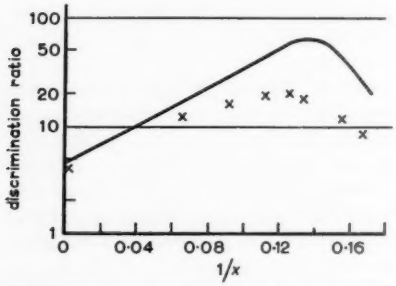
As all the conductors in the matrix are earthed, except the two selected conductors, then, although the selected electroluminescent cell will receive a voltage pulse of amplitude V, all other cells along the selected line and column will receive a voltage pulse of amplitude $\frac{1}{2}V$, thus giving rise to interference light signals. The maximum number of lines which may be used on a matrix is therefore governed by the discrimination that may be achieved between a selected '0' at the intersection of a row and column of '1's, and a selected '1'.

It is found that the peak light output follows the equation:

$$B = a \exp(-b/\sqrt{V}) \quad . \quad . \quad . \quad . \quad (1)$$

where B is the peak light output, a and b are constants, and V is the amplitude of the excitation voltage pulse. Thus, if the brightness B is reduced, the ratio between the wanted and unwanted signals may be increased by virtue of the extremely-high-power law expressed in eqn. (1). However, as the brightness is reduced, the system becomes more sensitive to the emission of individual quanta of light, and in fact the shape

of individual light pulses becomes extremely variable. Integration of the signal at the photomultiplier anode has the effect of reducing the variability of the detected light output signal. The optimum condition for this system seems to be a



2 *Discrimination ratio for 16 × 16 matrix*
The curve is for $b/\sqrt{V} = 12$
Crosses denote experimental points

5 microsec excitation period followed by a 5 microsec integration period.

Selection of a cell

Fig. 1 shows the method of selecting a single cell in a matrix. Voltage pulses of amplitude $+\frac{1}{2}V$ and $-\frac{1}{2}V$ are applied to the selected row and column of the matrix. If a voltage pulse of amplitude, $\pm V/x$ is also applied, as shown in the Figure, all the non-selected row and column intersections will receive voltage pulses of amplitude $2V/x$, while the cells along the selected row and column have pulses of amplitude $\frac{1}{2}V - V/x$, except at the major intersection where there is a pulse of amplitude V.

The biasing system allows the discrimination ratio to be controlled, and this may be theoretically predicted as a function of x (Fig. 2). The experimentally obtained points lie on a curve similar to that of the theoretical points, but the discrimination ratio is lower because of light scattering caused by total internal reflection in the glass of the matrix. The optimum value of x in any experimentally realizable system lies in the region 7—8·5. These discrimination-ratio calculations indicate that a 64 × 64 matrix may be used in a permanent store of this type; but, because of the light-scattering difficulties, in practice this is reduced to 32 × 32.

The fastest practical operating speed is limited by the 5 microsec excitation period followed by a 5 microsec light-signal integration period, giving a 10 microsec delay before the information is available, together with a rest period to allow the phosphor afterglow to decay. It is found that the afterglow of the zinc sulphide phosphor at present in use limits the minimum digit repetition period to 30 microsec. This may be improved by 20% if the operating temperature is raised to 100°C.

Thus the simple electroluminescent matrix may be used as a punched-card reader, or as a permanent store by placing masks in front of it. The maximum matrix size is governed by the discrimination ratio between the wanted output and the interference from the background outputs. In practice this is a 32 × 32 line matrix. With a digit period of 30 microsec this gives a sequential-selection-cycle time for the matrix of 31 millisec.

621.383.2 : 681.142

Fast-reading digital-computer store

A brief article based on a Measurement and Control Section paper (3178) entitled 'A digital-computer store with very short read-time' by Prof. T. Kilburn, M.A., Ph.D., D.Sc., Member, and R. L. Grimsdale, M.Sc., Ph.D., Graduate. The paper was published individually in January 1960 and will be republished in Part B of the Proceedings. It was read at Savoy Place before the Measurement and Control Section at a meeting on the 1st March 1960 (reported on p. 515). Prof. Kilburn is Professor of Computer Engineering, and Dr. Grimsdale is in the Electrical Engineering Department, at the University of Manchester.

In the paper are described the principles of operation and construction of two low-cost storage units with very-rapid-reading access. In one of these the information is of a permanent form but occasional changes by a simple manual operation are permitted, and in the other a complete change of all or part of the 100000 bits can be made in under 1 min.

Each digit cell in each of these stores is formed basically by two sets of windings which form the primary and secondary of a transformer, and the two binary states are determined by the presence or absence of a piece of linear ferrite material coupling the windings.

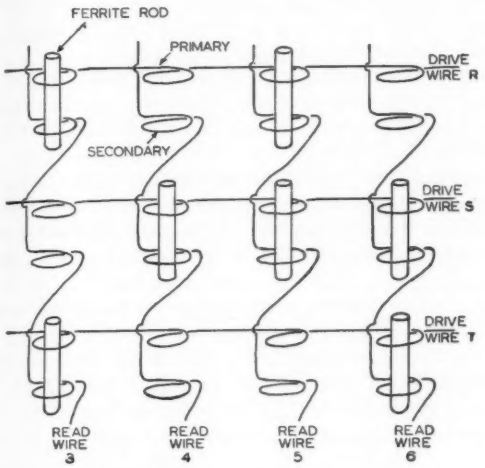
The storage system is arranged as shown in Fig. 1 so that the individual digits of a word are read out in parallel. A word is selected by passing a current pulse through the appropriate drive wire (for example drive wire S). E.M.F.'s will be induced in those read wires (4, 5, 6) which are coupled by ferrite rods to the chosen drive wire. In contrast a negligibly small e.m.f. will be induced in read wire 3 because there is no ferrite rod coupling this to the drive wire.

The read-signal waveform is the differential of the drive current, and the access time to the store is limited only by the rise-time of the drive-current pulse, the behaviour of the ferrite material at very high frequencies, and the transmission times for the signals in the store and in the associated equipment.

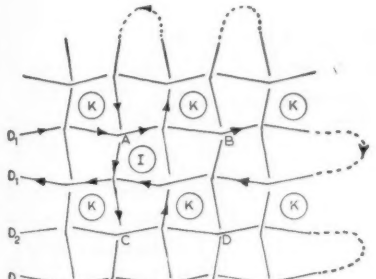
In practice the access time is determined by the bandwidth of the read amplifier. In one of the stores which has been constructed, the time to obtain information is 100 millimicrosec and the store may be read every 200 millimicrosec.

Semipermanent store

The semipermanent version of the store is constructed using a mesh woven with insulated copper wire. The primary or drive wires are formed by adjacent pairs of wires of the warp, and the read wires are formed by adjacent pairs of the weft (Fig. 2). The mesh, which has approximately 18 meshes per inch, is backed with a thin layer of Plasticine, and ferrite



1 *General arrangement of storage system*



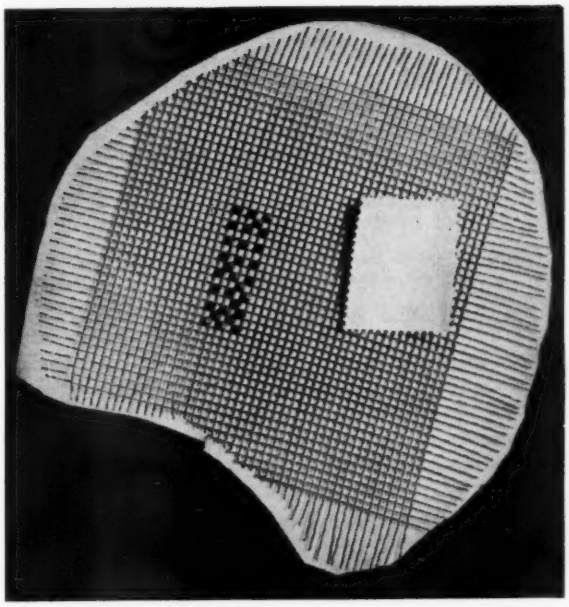
2 *Store using woven mesh*

rods 1 mm in diameter and 6 mm long are inserted in the mesh where required and held by the backing material.

In Fig. 2, positions A, B, C and D are information cells, and rods may be inserted in these positions to represent stored 'one' digits. Other ferrite rods are placed permanently in surrounding positions. These additional rods act as 'keepers' and provide return paths for the flux in the information rods.

A sample portion of the mesh with some of the keepers and six information rods is shown in Fig. 3.

The capacity of the store which has been constructed is 4096 words of 48 bits, and the mesh is arranged with 256 drive-wire pairs along the length of the warp and 16 sets of 48 read-wire pairs. The store is thus arranged in 16 blocks each of 256 words. The selection of blocks is accomplished by choosing one out of 16 in the case of each of the 48 sets of 16 read wires. The appropriate read wires are selected by junction-transistor switches before the input stage of the



3 *A sample portion of the mesh*

transistor read amplifier, and block switching is completed in under 1 microsec.

Changeable store

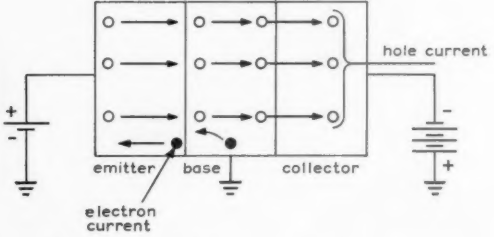
In the changeable version of the store the ferrite rods are held in small tubes. The windings are arranged so that there is a primary and secondary turn at each end of the tube, and these are connected so that the induced e.m.f. will be in one sense when the rod is at one end of the tube and in the opposite sense when it is at the other end. The rods are moved by a travelling system of air jets with the air flow controlled by solenoid-operated valves.

The semipermanent version of the store is intended to be used for library programme instructions and permanent data and the changeable version for large programmes. Their employment will result in an increase in the over-all speed of the computer, and erasable high-speed storage capacity will be made available for other purposes. 621.374.32 : 681.142

Junction transistors and their applications

A short article based on a Graduate and Student Section paper with the above title by J. A. Chandler, B.Sc.(Eng.), Graduate. The paper was read at Rugby before the Rugby Graduate and Student Section on the 15th October 1958 and it was awarded a premium by the Council. The author is with Associated Electrical Industries (Rugby) Ltd.

In a semiconductor, conduction takes place in a solid medium which has a crystal lattice structure, each atom linking its four valence electrons in covalent bonds with an electron from each of four other atoms. Any atom of another material introduced into the lattice is known as an impurity,



1 *Germanium transistor, p–n–p type*

and if it has five valence electrons, there is one electron left over after the formation of covalent bonds, so this is free to act as a carrier. The material is called *n* type (negative carriers). If an impurity with three valence electrons is introduced, this completes only three bonds, and the vacancy in the lattice is found to act as a positive carrier, called a 'hole' (*p*-type material).

When *p* and *n* types are made in contact, the boundary between them is a *p–n* junction, and carriers diffuse across the junction, forming a potential barrier which prevents further flow. If an external voltage is applied so that the carriers are driven towards the junction (forward bias), they can cross it and current flows. On reversing the applied voltage the carriers are attracted away from the junction. The small current which flows is due to electrons being thermally excited from their bonds, giving free electrons and holes in the junction region.

The transistor

A transistor is formed by constructing two *p–n* regions back to back, as shown in Fig. 1. The centre region is known as the base, and the outer regions are the emitter and collector. To operate the transistor, the collector–base junction is inversely biased, so that only a small current flows. Then the emitter is forward biased and a current flows into the emitter. Owing to the small base-width used, the holes coming into the base from the emitter will diffuse across to the collector before they have had time to combine in the base region. The collector current is thus controlled by the emitter current.

This method of biasing is called common base; the input circuit, emitter to base, is of low impedance, and the output circuit, the collector, is of high impedance, with a current gain of almost unity.

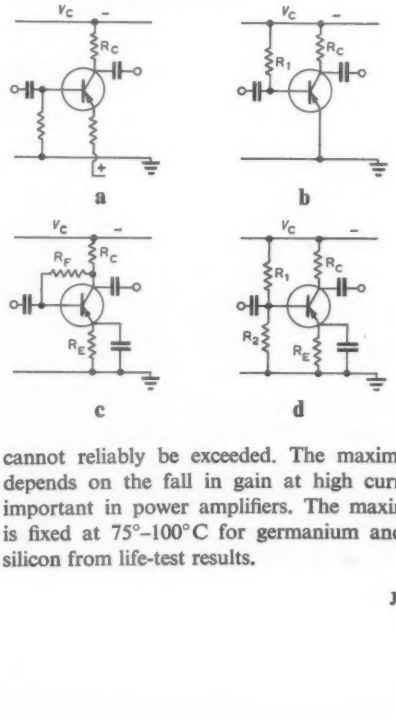
A more useful arrangement is the common-emitter connection, where both the collector–emitter and the base–emitter junctions are biased negatively, and the base is used as the input electrode with the load in the collector circuit. The current gain is now larger than unity, commonly 50; and the input impedance is higher, and output impedance lower, than with the common-base connection.

The third possible connection is the common collector, or emitter-follower, with the load in the emitter circuit and the base the input electrode. This has a voltage gain of unity, high input impedance and low output impedance.

Limitations

The maximum allowable voltage is fixed by junction breakdown, but it is of course given a production limit which cannot reliably be exceeded. The maximum current limit depends on the fall in gain at high currents, particularly important in power amplifiers. The maximum temperature is fixed at 75°–100°C for germanium and 150°–200°C for silicon from life-test results.

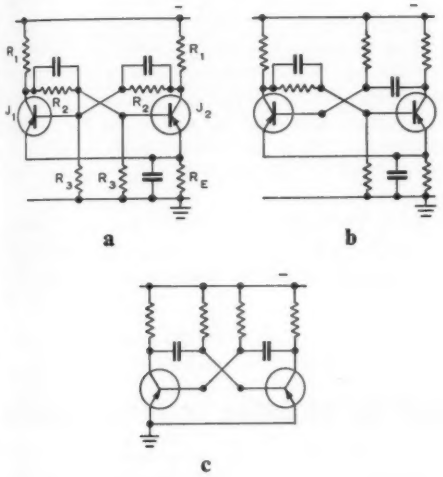
2 *Common-emitter bias supplies*
a separate battery supply
b fixed bias
c self-bias and emitter resistor
d potentiometer chain



The power dissipation in the transistor raises the junction temperature, so that the power limit is determined by the ambient temperature and cooling arrangements. Frequency limitations are due to the carrier transit time and internal capacitances associated with the junction. The frequency response depends on the base-width, so a narrow base will improve this, but there is obviously a practical limit. The accepted way of specifying the frequency response is by the α cut-off frequency, which is where the current gain in the common-base connection is 3dB down. (Other terms are being suggested for v.h.f. transistors.)

Bias arrangements

In the common-emitter arrangement the leakage current I_{co} is multiplied by the current gain and called I_{ce}. As this is temperature-sensitive, some form of stabilization is required. For example, if I_{co} is 5μA at 25°C, I_{ce} could vary from 0·25 to 4mA from 25° to 55°C. Fig. 2 shows the various

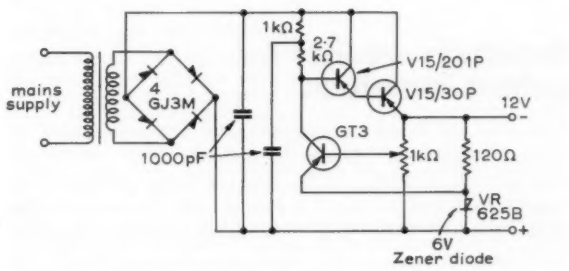


3 *Multivibrator circuits*
a bistable circuit
b monostable circuit
c astable circuit

biasing methods; Fig. 2a shows the bias arrangement using a separate battery in series with a resistor to determine the emitter current. If the resistor is large enough, the current is held constant. Fig. 2b shows simple fixed base-current bias, but this provides no stabilization. Fig. 2c shows d.c. feedback from collector and emitter giving some stabilization; and the most common method, shown in Fig. 2d, uses a bias chain to fix the base potential so that the emitter resistor determines the bias current.

Circuit applications

Transistors have been applied to most types of amplifier, from low-frequency small-signal circuits up to the power and frequency limits of available transistors. Switching circuits have been widely used, since the transistor is a very good switch, with a small voltage drop in the 'on' or saturated state, and a high series resistance in the 'off' state. There is also the transition region, as the transistor is switched off–on or on–off. The peak power dissipation during switching may be



4 *Series stabilizer with feedback: 12 volts, 0–1 amp*

many times the rated continuous power, if the transition is sufficiently fast.

An example of a switching circuit is the Eccles–Jordan bistable circuit shown in Fig. 3a. This is stable with either J_1 on and J_2 off or vice versa, and is switched over by suitable trigger pulses. This can easily be modified to give monostable or astable circuits as shown in Figs. 3b and 3c.

An important application of the transistor is as a convertor of d.c. power from one voltage to another, since it can maintain high efficiency from very low power levels up to the maximum obtainable from the transistor, with a high enough frequency to simplify smoothing. Switching-type circuits are more efficient than sine-wave oscillators and so are normally used. Units have been built operating from 400c/s to 10kc/s with efficiencies from 50 to 80% at power levels from milliwatts to watts.

A further application is in the provision of stabilized supplies. A fixed 12volt supply is shown in Fig. 4, which is of the series type with feedback and a Zener diode as a reference. Such units providing up to 30 volts at 10amp are available commercially.

The immediate future

The extensions in the types and ratings of transistors in this country can be estimated by comparison with the United States. Low-power audio transistors are similar, except that *n–p–n* types are available in the United States. High-power units are available there up to 100 volts 13amp, compared with 60 volts 8amp in the United Kingdom. The greatest differences are to be found in the r.f. transistors, a number of new types being available in the United States but not in this country, some of these being developments of the simple junction transistor and others having somewhat different modes of operation. Silicon transistors are now being produced in this country, and the scope of present applications will be widened as all these transistor types become available.

621.382.333

Synopses of papers

THE following are synopses of papers published in the *Proceedings* which have not been reviewed in the *Journal*. They are included here primarily for reference. Reprints will be available about two months after publication

Resistivity monitor for sodium impurities

A synopsis of a Measurement and Control Section paper (3278) entitled 'Resistivity monitor to indicate oxide content of sodium' by L. R. Blake, Ph.D., B.Sc., Associate Member. The paper is published this month in Part A of the Proceedings. The author is at the U.K.A.E.A. Dounreay Experimental Reactor Establishment.

THE electrical resistivity of sodium or sodium–potassium is continuously measured while it is flowing at operating temperature in a pipe, to provide an indication of impurity level, particularly oxygen, and thus to enable progress of clean-up in liquid-metal loops to be followed and to give assurance that high purity is achieved and maintained.

The meter is designed to be sensitive to a change of one part in 10^6 in oxygen level, corresponding to a change in resistivity of about one part in 10^4. A change in liquid-metal temperature of only 0·04°C will also produce this effect, and hence temperature compensation and achieving high stability are the chief problems of the design.

Two types of resistivity meter are described, both of which have been installed in the Dounreay fast reactor. Tests indicate that the design objective has been achieved and the value of the meter as an impurity monitor has been proved.

621.317.73

Ferrite-core memory systems

A synopsis of a Measurement and Control Section paper (3307) entitled 'Ferrite-core memory systems with rapid cycle times' by D. B. G. Edwards, Ph.D., M.Sc., Associate Member, M. J. Lanigan, M.Sc., and Prof. T. Kilburn, M.A., D.Sc., Ph.D., Member. The paper will be published in Part B of the Proceedings.

It was read before the Measurement and Control Section on the 1st March 1960 at Savoy Place (see p. 515). Dr. Edwards and Mr. Lanigan are in the Electrical Engineering Department, Manchester University, and Prof. Kilburn is Professor of Computer Engineering, Manchester University.

IMPROVEMENTS in storage systems using currently available square-loop ferrite cores are considered. These enable the normal cycle time of 6–10microsec to be reduced to less than 2microsec. Effort has been concentrated on the word-selected two-core-per-digit arrangement, and the most promising techniques are those which involve partial-flux switching. A system is developed suitable for a store of 1024 words of 52 digits with a cycle time of about 1·6microsec. In a smaller store of, say, 100 words, a cycle time of approximately 0·6microsec is feasible.

621.318.12:621.374.32

Parallel arithmetic unit

A synopsis of a Measurement and Control Section paper (3302) entitled 'A parallel arithmetic unit using a saturated transistor fast-carry circuit' by Prof. T. Kilburn, M.A., D.Sc., Ph.D., Member, D. B. G. Edwards, Ph.D., M.Sc., Associate Member, and D. Aspinall, M.Sc. The paper will be published in Part B of the Proceedings. It was read before the Measurement and Control Section on the 1st March 1960 at Savoy Place (see p. 515). Prof. Kilburn is Professor of Computer Engineering, Manchester University, and Dr. Edwards and Mr. Aspinall are in the Electrical Engineering Department, Manchester University.

THE authors describe a transistor switch technique which is of particular importance in applications where a large number of switches have to be connected in series and where the propagation time of information through these switches has to be a minimum. It is thus of importance in parallel addition, and its use in this connection has been successfully demonstrated, yielding an addition time over 24 digits of 200millimicrosec.

The technique is reasonably economical and the authors show how it can be used in conjunction with more conventional logical circuits to provide a simple arithmetic unit.

621.374.32:681.142

Correlator for vocoder control signals

A synopsis of an Electronics and Communications Section paper (3295) entitled 'A correlator employing Hall multipliers applied to the analysis of vocoder control signals' by Prof. A. R. Billings, B.Sc., Ph.D., Associate Member, and D. J. Lloyd, B.Sc.(Eng.), Ph.D., Graduate. The paper will be published in Part B of the Proceedings. Dr. Billings and Dr. Lloyd were formerly in the Department of Electrical Engineering, University of Bristol. Dr. Billings is now Professor of Electrical Engineering, University of Western Australia, and Dr. Lloyd is with the National Research Council, Ottawa.

AFTER discussing short-term correlation functions, the authors describe the design and performance of an auto- and cross-correlator using Hall-effect multipliers. It is shown that these devices are well suited to act as the multiplying elements and as modulators in associated circuits, provided that one of the time functions to be multiplied has a narrow bandwidth. Examples of measured auto- and cross-correlation functions are given for sine waves and noise and for the control signals of a vocoder, from which interesting conclusions can be drawn about the redundancy of vocoder signals.

621.376.22

OBITUARY

JOHN HAROLD BUCHANAN

John Harold Buchanan, B.SC., who died at his home at New Galloway, Kirkcudbright, on the 15th April 1960 was born at Edinburgh on the 1st July 1885.

His education at Morelands School, Edinburgh, was followed by technical education at Heriot–Watt College, Edinburgh, where in 1904 he was awarded a diploma with distinctions, and at Edinburgh University, where he received the B.Sc. degree in engineering in 1906.

After two years' practical training with West End Engine Works Co., Edinburgh, he joined Middleton and Townsend, Edinburgh, as a designer-draughtsman until 1910, when he was appointed assistant lecturer under Prof. F. Bailey, becoming assistant professor in electrical engineering and lecturer on design in 1913, at Heriot–Watt College. During the First World War he served with the Ministry of Munitions in Scotland.

He joined Metropolitan-Vickers Electrical Co. in 1920 and remained there until his retirement in 1952. During the greater part of this period he was in charge of instrument-transformer design, in which sphere he became an acknowledged expert and in connection with which he was a prominent member of several B.E.A.M.A. and B.S.I. committees.

Of a courteous and kindly disposition, he was an engineer of extremely sound judgment and outstanding technical ability, and he was responsible for many advances in the design of instrument transformers.

During his earlier life he was fond of walking and climbing and he became a life-member of the Scottish Mountaineering Club. His interest in railways led him to construct model locomotives, at which he was extraordinarily skilful. He took an enthusiastic interest in this hobby and was at one time chairman of the Manchester Model Railway Society. He was also very well informed on music. He is survived by his widow and two sons.

He joined The Institution as an Associate Member in 1915 and was elected a Member in 1944. He was awarded a Silvanus Thompson premium for his paper entitled 'Design, construction and testing of voltage transformers', which was published in the *Journal* in 1936. N. A.

PERCY CLEASBY JONES

Percy Cleasby Jones who was born in Manchester on the 21st January 1885 died on the 28th April 1960. In 1902 he joined the British Westinghouse Electrical and Manufacturing Co., Manchester, as an office boy earning 6s. a week, directly attached to Mr. H. S. Loud, general manager of the company. The benefit of this early association was shown during his many years in the electrical industry. He was transferred to the motor-control section in 1903, studying part-time at Manchester University from 1907 to 1912, and remained interested in this branch of the industry for the rest of his business life.

In 1911 he joined Allen West, Brighton, which company had just been formed, in charge of their Manchester office, from which centre he was responsible for their activities in the Midland and the Northern parts of the British Isles. On the outside staff, in association with the late Mr. Allen West and others, he helped to lay the foundation of the company. In 1931 he was transferred to the Brighton works as sales director, which position he held until his retirement in 1957. For the whole of this latter period he resided at Kingstonridge, Sussex, where he spent a very happy life.

In his early years he spent many hours cycling in company with his father through Cheshire, Derbyshire and North Wales, and his later travels through Great Britain on business gave him an intimate knowledge of most of the beauty spots in the country he loved so much. His chief hobby was photography, and his albums testified to the interest he took in the cathedrals, churches and beauty spots of England.

He was deeply devoted to his family, as he was to his friends, and never failed to unobtrusively help any whom he knew were in need. His strong feelings relating to his country and the Empire were clearly shown by his admiration of Nelson and Kipling, in both cases amounting to hero-worship. He is survived by his widow, a son and a daughter.

He joined The Institution as a Student in 1904 and was elected an Associate Member in 1912 and a Member in 1949. He was awarded a Student premium for his paper entitled 'Starters and controllers' and an extra Student premium for his paper entitled 'Single-phase railways', which were published in the *Journal* in 1908 and 1909 respectively. J. M. L. S.

ROBERT SHAW MILLER

Robert Shaw Miller who died on the 8th March 1960 at his home in Ashton-under-Lyne was born in Glossop on the 6th May 1886. He was educated at New Mills Science School, Derby, and then joined Manchester Urban Electric Supply for three years' practical experience. In 1903 he became an assistant in the station of Manchester College of Technology, studying part-time at the college until 1908, when he obtained the diploma in electrical engineering. He joined Ashton-under-Lyne Electricity Department in 1907 as an inspector.

He was employed as electrical engineering surveyor with the National Boiler and Electrical Insurance Co. from 1911 to 1918, when he went into business on his own account as an electrical engineer and contractor. In 1924 he became chief electrical engineer with Oldham and Son, Denton, where he remained until his retirement a few years ago. For the last five years of his employment, he acted in a consultative capacity on research and development.

In the early years of the Second World War he introduced a 'static charger', which was a method of charging miners' lamp batteries on a constant-potential system from a transformer-rectifier supply. This replaced the old system of charging from a motor-generator and was very widely adopted.

In his retirement he still retained his interest in electrical engineering by experimenting with various types of electrical apparatus in his private workshop at his home. He was a keen cyclist. He is survived by his widow and a son.

He joined The Institution as an Associate Member in 1919 and was elected a Member in 1950.

DOUGLAS HARRY ROBINSON

Douglas Harry Robinson who was born on the 17th October 1892 died on the 25th November 1959. He was educated at Longton High School, Stoke on Trent, and part-time at Armstrong College and at Stoke on Trent Technical Institute while receiving practical training with Potteries Electric Traction Co. and the Newcastle upon Tyne Electric Supply Co.

On the completion of his training in 1913, he joined the A.E.G. of Berlin as an assistant engineer before serving in the First World War. In 1919 he became electrical engineer with Singapore Electric Tramways and in 1922 joined the H.B.M. Post Office wireless station at Abu Zabal, Egypt, as engineer officer.

He became resident engineer with Siemens Brothers in 1924 and was engaged on the construction of the 66kV overhead transmission line from Maentwrog to Legacy for the North Wales Power Co. He joined Pirelli-General Cable Works in 1927, and on the formation of the overhead-line department in 1928 he was appointed chief engineer and manager of the department, being responsible for the construction of two large sections of the original 132kV transmission-line system of the Central Electricity Board in the South-East and Mid-East England schemes. In 1933 he left Pirelli-General and became responsible for transmission-line work for the Punjab Public Works Department. At the time of his death he was chief electrical engineer of the Ministry of Works at Khartoum.

He was a very active and engaging personality, who earned the esteem of his colleagues. He was twice married and is survived by his widow.

He joined The Institution as an Associate Member in 1934 and was elected a Member in 1939. He served on the Lahore Oversea Committee from 1941 to 1946. J. R. H.

CHARLES HUBERT SMITH

Charles Hubert Smith who died at his home in Norwich on the 13th April 1960 was born on the 17th September 1882. He was educated at Regent Street Polytechnic, London, and in 1900 joined the London Electric Supply Corporation, transferring to Marylebone Electric Supply, London, in 1905 as assistant mains superintendent and later as constructional engineer. While with the company he invented the first-known immersion heater, rated at 6kW, for direct connection to the mains.

In 1916 he became works manager with Belling, leaving in 1920 to join the late Cmdr. F. L. Newhouse to found Electric Fires Ltd., Norwich, using the trade name 'Heatrae'. Commencing with electric fires, the company extended its range of products, and at the time of his death manufactured types of electric heating for domestic, commercial and industrial use. His name will, in particular, always be associated with the field of electric water-heating, in which he was a recognized authority.

He joined The Institution as an Associate Member in 1909 and was elected a Member in 1945. He was a Member of the Institution of Heating and Ventilating Engineers. G. R. S.

ALASTAIR WILLIAM DICK

Alastair William Dick, B.SC.(ENG.), who died on the 19th May 1960 was born on the 16th October 1899. He was educated at Southgate County School, London, and then served in the Royal Navy towards the end of the 1914–18 War, visiting Italy several times. In 1919 he commenced a four-year course at City and Guilds College in electrical engineering, and was awarded a B.Sc.(Eng.) degree.

He then completed a two-year apprenticeship course with English Electric, Stafford, which was followed by a period as junior assistant with Bells United Asbestos Co., Harefield, as chief wireless operator with Marconi International Marine Communication Co., and as principal assistant with British Power Railway Signal Co.

In 1929 he joined the British Electrical Transformer Co., Hayes, as engineer-in-charge on tap-changing and voltage-control gear. In 1948 he was transferred to take charge of the order and contracts section, and it was during this period that he became well known to so many in the electric supply industry. His willingness to assist and his earnest desire to see that specification details were met in all requirements always ensured that relations between company and customer were maintained at the highest level.

In his youth he had been keen on swimming, but later he had only a limited interest in sports and concentrated his interest on his house and garden. A considerable amount of his spare time was taken up in lecturing at Slough Technical College, where he was a senior lecturer for many years. His final months were clouded by a severe illness which would have been too much for many men, but he, with great courage and determination, attended work up to the day before he died. He is survived by his widow and two daughters, and will be missed by a very large number of friends who held him in high regard.

He joined The Institution as a Student in 1922 and was elected a Graduate in 1927, an Associate Member in 1930 and a Member in 1947. E. E.

GEORGE THOMAS EDGAR

George Thomas Edgar who died in Dunedin, New Zealand, on the 17th August 1959 was born in Tapanui on the 2nd April 1886. He was educated at a New Zealand district secondary school and obtained his engineering education through a correspondence course and private study, and part-time study at Dunedin Technical School, receiving practical experience with W. G. T. Goodman and with Noyes Brothers.

He joined Dunedin Transport and Electricity Department as chief draughtsman in 1908. In 1915 he was appointed assistant city electrical engineer and in 1938 city electrical engineer, continuing in this position until he retired in 1955. When Her Majesty the Queen visited Dunedin in 1954, he was awarded a gold medal in recognition of his service to the city and to the electrical industry in Dunedin.

He maintained a close interest in the technical aspects of radio-communication, being associated with Dr. Jack, Professor of Physics at Otago University, when the first experiments to be undertaken in Dunedin led to successful transmissions.

He was a past-president of the Electrical Supply Authorities' Association Engineers' Institute and a member of the New Zealand Institution of Engineers. During the Second World War he was deputy controller of the Dunedin Emergency Precautions Scheme. He was a member of the Dunedin Rotary Club for many years and a past-master of the masonic order.

He was predeceased by his widow in 1958 and is survived by a daughter and two sons.

He joined The Institution as a Graduate in 1915 and was elected an Associate Member in 1921 and a Member in 1945. He served on the New Zealand Oversea Committee from 1941 to 1958. S. R. A.

LEONARD FRANK JEFFREY

Leonard Frank Jeffrey, B.SC.(ENG.), who died on the 5th May 1960 was born on the 11th April 1896. He was educated at Whitgift School, Croydon, and apprenticed to Leith and Blackman, Arbroath, followed by three years at Battersea Polytechnic after serving in the Royal Navy in the 1914–18 War.

After experience with the Gas Light and Coke Co. at their Beckton works, he joined the construction staff of Birmingham Electricity Supply Department in 1925, being appointed chief assistant constructional engineer in 1930. In 1936 he became technical assistant and constructional engineer with the West Midlands Joint Electricity Authority, Wolverhampton. Following the death of the chief engineer and manager and later the retirement of the chief generating engineer in 1942, he became responsible as chief engineer for all the generation, operation and design of the authority and continued in this position until the industry was nationalized in 1948, when he was appointed chief construction engineer of the Midlands Division of the British Electricity Authority.

He became controller of the division in 1951, retaining this position until his retirement due to ill-health in 1957.

He was keenly interested in education and training matters, and had been a member of the Court of Governors of Nottingham University for many years, as well as serving on the Engineering Advisory Committee. He was a past-president of the Junior Institution of Engineers and a member of the Batti Wallahs Society.

His illness interrupted a useful life in which he had found much happiness in his profession, in his family life and in the many interests that he had in general. He became an enthusiastic golfer, but to the end maintained a close interest in church life and in his family. He was a kind and rather gentle person with a considerable sense of humour, and, as a result, he had a very wide circle of friends to whom his passing was a real sorrow. It could truly be said of him that in his work, in his home and in his interests he maintained a sense of vocation and purpose which is not given to all of us, and he has left a number of valuable monuments to his memory in these spheres.

He joined The Institution as an Associate Member in 1931 and was elected a Member in 1939. He served on the South Midland Centre Committee from 1941 to 1944 and in 1950–51.

J. A. S./O. S. W.

HAROLD ALEXANDER McGUFFIE

Harold Alexander McGuffie who died on the 23rd June 1960 was born at Motherwell in 1880. He was educated at Grove Park School, near Chester, and studied electrical engineering at Manchester Technical College. He then served a pupil apprenticeship with P. R. Jackson, Manchester, subsequently acting as their chief outside erection engineer.

After a short period with British Westinghouse, Manchester, he returned to the West of Scotland to take up the position of chief assistant with A. W. and M. Stewart, consulting engineers, Glasgow, but left in 1905 to join the late George Stevenson in founding Stevenson and McGuffie, and was actively engaged in this business until a few months before his death.

His chief interest was in the electrical equipment of mines and steelworks, and he was responsible for many power-plant installations at home and also in Spain. He took a keen interest in all aspects of mining work and was elected president of the Association of Mining Electrical Engineers in 1938. During his year of office, he inaugurated the association's Benevolent Fund, and remained convener of the Benevolent Fund Committee until he retired from active participation in the association's affairs in 1953. This interest in the welfare of his fellow-members was typical of his generous disposition, and, while he did not suffer fools gladly, he was a staunch and respected friend of many engineers in the mining industry.

In his earlier years he was an enthusiastic yachtsman, and he was a life-member of the Royal Clyde Yacht Club. He is survived by two married daughters.

He joined The Institution as an Associate in 1901 and was elected an Associate Member in 1905 and a Member in 1910. He served on the Scottish Centre Committee from 1939 to 1942.

T. D.

REUBEN FREDERICK WINDER

Reuben Frederick Winder, known to his intimate friends as 'Ben', who was born on the 4th April 1899 died on the 22nd April 1960.

He was educated at King's School, Canterbury, where he was very interested in all games, being games captain and also captain of rugby. During the 1914–18 War he served with the Royal Flying Corps and later gained his wings as a pilot in the Royal Air Force. He entered Faraday House in 1919 for four years, and from 1923 to 1924 was employed by W. T. Henley's Telegraph Works Co. in their foreign sales department.

He then joined the Northmet Power Co., Chingford, and was engaged in the electrification of the town at its beginning. He later went to Royston and Hoddesdon as assistant engineer. He transferred in 1931 to Hertford district as sales engineer, in 1937 became first assistant engineer and was appointed district superintendent in 1938. In 1952 he transferred to the Hendon district of the Eastern Electricity Board as manager and about a year before his death was appointed manager of the Chiltern sub-area.

His hobbies were mainly his work and some gardening. He was an active member of Rotary, and spent some time when at Hertford in lecturing at evening classes. He was of a happy disposition, although a serious-minded man. He was well liked by all those with whom he came in contact. He is survived by his widow and two daughters.

He joined The Institution as a Student in 1920 and was elected a Graduate in 1926, an Associate Member in 1928 and a Member in 1946.

C. R. M.

Paper and monograph

published individually this month

Papers accepted for reading at meetings, and monographs, are first published individually and are republished later in the Proceedings of The Institution; as soon as the separates are available, they are described in this feature. The papers are supplied free of charge; the price of a monograph is 2s.

In addition, reprints of papers read at meetings, including the discussions thereon, and of papers not read at meetings, become available, price 2s., about two months after their appearance in the Proceedings.

Applications quoting the serial number of the paper, monograph or reprint as well as the author's name, and accompanied by a remittance where appropriate, should be addressed to the Secretary of The Institution. For convenience, books of five vouchers for this purpose can be obtained in advance, price 10s.

Those who obtain a copy of a paper published individually are urged—if they do not take the Part of the Proceedings in which it will be republished—to apply in due course for a reprint, as this is the final and correct version and includes the discussion.

PAPER

Basis for short-circuit ratings for paper-insulated cables up to 11kV *Paper* 3314S, *Part A*

L. GOSLAND, B.SC., *and* R. G. PARR, B.SC.(ENG.)

THE various factors which may determine the short-circuit rating of paper-insulated cables are examined, and individual limits are proposed for each which may be decisive. These are the temperature rise of the conductors, the sheath temperature, and the peak current.

The application of these limits to a range of cables is illustrated.

MONOGRAPH

Magnetic field and centring force of displaced ventilating ducts in machine cores *Monograph* 394U

K. J. BINNS, B.SC.

THE author examines analytically the field between equal stator and rotor ducts when displaced from each other, and evaluates for any relative position, the total flux crossing the air-gap and the amount entering the sides of each duct. The flux entering the sides of the stator ducts in a.c. machines varies at supply frequency, and produces eddy currents whose path is not restricted by the direction of the laminations and which consequently give rise to much loss. With relative displacement of the ducts, the fluxes entering the two sides of a duct become unequal and produce an axial magnetic force of engineering importance.

Numerical values are given for the variation of gap permeance and magnetic centring force, and are plotted in curves directly applicable to design calculation for ratios of duct to gap width varying from $\frac{1}{2}$ to 5 and for any relative displacement.

New transatlantic cable

A NEW transatlantic telephone cable—to be known as TAT 3—will come into operation in 1963, carrying 128 telephone circuits between the United Kingdom and the United States. The number of telephone calls between the two countries is already $3\frac{1}{2}$ times greater than it was before the first transatlantic telephone cable was opened in 1956, and is growing at the rate of about 500 a month.

TAT 3 will run directly between the United Kingdom and the United States, unlike the two existing transatlantic telephone cables which both land in Newfoundland. The landing-points have not yet been agreed on by the British Post Office and the American Telephone and Telegraph Co.

The cable, whose total length will be about 3400 nautical miles, will be of the lightweight type, using polythene insulation without external armouring. The over-all diameter of the deep-sea cable will be about $1\frac{1}{4}$in. A single cable will be used to carry speech in both directions.

The 128 circuits can be used for speech or telegraphy as required. The cable will transmit radio-programme material, but the bandwidth will not be sufficient for the transmission of live television. At first, some of the circuits will be used for telephone calls to Europe, and so provide some relief to the cable between the United States and France, which was opened in 1959. The probable cost is about £12 million.

NUCLEAR POWER IN ANGLESEY

THE Central Electricity Generating Board have found three possible nuclear-power-station sites in Anglesey: at Wylfa, Carmel and Trefadog in the north-western part of the island.

These sites were considered together with that at Edern on the north coast of the Lleyn Peninsula, and the Board have come to the conclusion that, when a second nuclear power station (to supplement Trawsfynydd) is required in North Wales, they would propose to seek permission for the development of the Wylfa site, which is on the north coast of Anglesey, about $1\frac{1}{2}$ miles west of Cemaes Bay, in preference to the Edern site.

Their investigations have shown that Wylfa is marginally superior to Edern on economic grounds, and the Board's opinion is that it is by a similar margin also more acceptable from the planning and amenity points of view.

The revised nuclear-power programme means that a station at Wylfa will not be required in the period up to and including 1966, so that construction could not commence before 1963 at the earliest.

TECHNICAL PUBLICATIONS

FURTHER information and copies of the publications can be obtained from the organizations concerned except where otherwise stated

BRITISH BROADCASTING CORPORATION

Television field trials of 405-line and 625-line systems in the u.h.f. and v.h.f. bands 1957–1958. B.B.C., London, 1960. 20s.

THE report is that of a working party of the Television Advisory Committee set up by the Postmaster General in 1952. The results are given of field trials of 405-line transmission in Bands I and V and of 625-line transmission in Band V.

BRITISH ELECTRICAL AND ALLIED INDUSTRIES RESEARCH ASSOCIATION

Report F/T198 **Soil classification for cable engineers. E.R.A. simplified system** by M. J. Vanner. 10s. 6d., plus postage

THIS system depends on visual inspection and handling of the soil. Successful trials have been made.

BRITISH STANDARDS INSTITUTION

B.S. 204: 1960 **Glossary of terms used in telecommunication (including radio) and electronics.** 35s.

COLLATES all the terms previously covered by B.S. 204 and its supplements published from 1948 to 1951. New sections deal with semiconductor devices, information theory and inductive co-ordination.

B.S. 3238: Part 1: 1960 **Graphical symbols for components of servomechanisms.** Part 1—Transductors and magnetic amplifiers. 4s. 6d.

TYPICAL diagrams are included to exemplify the use of the symbols. An appendix deals with polarity marking, including the convention indicated in B.S. 822 and the dot conventions.

BUTTERWORTHS SCIENTIFIC PUBLICATIONS

Decimal coinage and the metric system. Should Britain change? Butterworths Scientific Publications, London, 1960. 7s. 6d.

THIS is a joint report of committees appointed by the British Association for the Advancement of Science and the Association of British Chambers of Commerce. The inquiry dealt particularly with the cost of change: on the whole, the committees reported that a change to decimal coinage was desirable and any action taken need have no international complications; on the other hand, as regards weights and measures, a gradual evolution is recommended.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

Cmnd. 1049 **Report of the Research Council for the year 1959.** H.M.S.O., London, 1960. 4s. 6d.

DETAILS are given of research grants and training awards, the functions of the research stations and associations and the co-operation between them, links with the universities, etc. In particular, the new role of the Radio Research Station means that over one-half of its total effort will be applied to space research, and the station plans to co-operate with the United States and Canada in a joint project for sounding the atmosphere from above.

The National Physical Laboratory Report for 1959. D.S.I.R., London, 1960. 8s., postage 7d.*

THE work over the year of the various divisions is described in detail, including research on magnetic resonance and polymer physics by the basic physics division, and the correlation of time and frequency standards in the United States and the United Kingdom by the standards division. The autonomics division, formerly the control mechanisms and electronics division, is working on the construction of planar cryotrons for very-high-speed computing, the self-optimization of industrial processes, and pattern recognition. It has also made a start on mechanical translation from Russian into English.

* Obtainable from H.M. Stationery Office

ELECTRICITY COUNCIL

Report of the proceedings of the conference of university professors on engineering problems in the electricity supply industry. London, 1959. 10s.

THE conference took place in November 1958 in London. Contributions deal with trends in generation design, problems of transmission and distribution, and research problems of the supply industry.

Utilization research report no. 14. **Comparative tests on heating office buildings by thermal-storage block-heaters and other methods.** London, 1960. n.p.

TEMPERATURE, consumption and load records taken in 11 converted office premises show that, although block-heaters are competitive with other methods of office heating, savings in consumption could be effected through improved automatic control to prevent overheating in mild weather and by means to enable the heat output to be regulated manually.

HEYWOOD AND CO.

British semiconductor guide—1960. Heywood, London, 1960. 5s.

THE 963 British-made semiconductor devices listed are presented in three main groups: transistors, diodes and rectifiers, and photosensitive devices, together with technical details and sources of supply.

Progress in cryogenics—Vol. 2. Edited by K. Mendelssohn. Heywood, London, 1960. £3 3s.

THE aim of this series is to provide summarizing articles by authors in various countries on different topics in the field of low-temperature technology, this volume containing eight such items. Articles on the separation of deuterium on an industrial scale by low-temperature distillation, resistance thermometers for low temperatures, the 3-level solid-state maser, and methods of nuclear orientation are included.

INTERNATIONAL ELECTROTECHNICAL COMMISSION

Publication 65 **Safety requirements for electric mains-operated radio receiving apparatus.** Appendix III—Particular specification for electric mains-operated television receiving apparatus. 4 Sw.fr.*

REQUIREMENTS and tests are given which should ensure personal safety against electric shock and harmful radiation, and safety against fire, excessive temperature and implosion.

Publication 67 **Dimensions of electronic tubes and valves.** 4th supplement. 6 Sw.fr.*

OAK RIDGE NATIONAL LABORATORY

Report ORNL 2828 **Tables for a semi-infinite circular current sheet.** Tennessee, 1959. $3†

THE tables include both the magnetic field intensity and the magnetic vector potential.

* Obtainable from the I.E.C. Central Office, 1 rue de Varembé, Geneva, Switzerland

† Obtainable from the Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C.

SOME RECENT BOOKS

PROGRESS IN DIELECTRICS—Vol. 2

J. B. BIRKS and J. H. SCHULMAN (*Editors*)

LONDON: HEYWOOD. 1960. 225 PP. £2 15s.

THE study of dielectrics results in many papers, but it may be doubted whether basic understanding of the subject advances quickly enough to justify an annual review of progress. Vol. 2 of 'Progress in dielectrics' encourages this doubt. In contrast with the first, which contained a substantial amount of original research reported at first hand, this second volume consists too largely of articles in which the review is more evident than the progress.

It opens with a good condensed account of dielectric theory, but containing little not already available in such standard texts as Fröhlich's 'Dielectric theory'. A subheading 'Some recent developments' raises hopes which are disappointed when the chapter ends 21 lines later.

Two sections cover the dielectric properties of polymers and of glasses respectively: the first very well done, but the second suffering from an uncritical presentation of data of all ages. The Arrhenius equation is not, in 1960, a novelty, even though applied to glass in 1908! Nor is the work of Curtis in 1914 of current significance for surface conduction.

The most original contribution is that on 'Irradiated polymers'—a very full account of present knowledge of the effects, temporary and permanent, of exposing polymers to radiation of various kinds. It is not quite without minor blemishes. The third nuclear equation on p. 85, if it occurs as printed, results in S^{35}, not Cl^{35}. To class fast neutrons with protons as 'densely ionizing particles' (p. 81) obscures the basically dissimilar origin of the ionization in the two cases. If the word 'telekilocurie' (p. 82) really exists, it should not.

The chapter on 'Artificial dielectrics' (lattice arrays of conducting objects) is a useful brief introduction to the topic. Another on high-permittivity ceramics for capacitors is concerned largely with details of industrial techniques, and seems somewhat alien to the rest of the book.

The articles are well documented, the total of references exceeding 500. Considered in isolation, this work will appeal most to those interested in the electrical properties of polymers. Considered as one part in a series, its value, in the reviewer's opinion, depends on the publishers' restraint in delaying Vol. 3 until there is an adequate number of *critical* reviews of *progress*.

C. G. GARTON

WAVE PROPAGATION AND GROUP VELOCITY

L. BRILLOUIN

NEW YORK: ACADEMIC PRESS. 1959. 154 PP. $6.50

THIS is a collection of papers originating from the collaboration of Sommerfeld and Brillouin on the problem of wave motion in dispersive media. The papers included are Sommerfeld (1914) on the general problem, Brillouin (1914) on the mathematical details, with special attention to the behaviour of the leading edge of a wavefront, and Brillouin (1932) on wave propagation in ionized media. These are prefaced by a short general introduction, and there is a final chapter stressing the dispersive nature of acoustic and electromagnetic wave propagation in pipes.

The author rightly says that these articles are not readily available today, especially to English-speaking engineers, and it is useful to have this well edited translation. However, the reader is probably entitled to feel some disappointment that more information on subsequent developments has not been given.

For instance, Sommerfeld stresses the failure to converge of the Fourier integrals for non-terminating wavetrains. The modern engineer immediately asks himself if Laplace transforms eliminate this difficulty. They do, and the problem is worked out in Stratton's 'Electromagnetic theory' (1941), but no reference is given. Also, the problem of pulse-shape distortion in dispersive transmission media has been extensively studied, and it is regrettable that this practical problem is not discussed.

The book furnishes an elegant presentation of an elegant investigation in classical physics.

A. H. W. BECK

ELECTRONICS FOR SPECTROSCOPISTS

C. G. CANNON (*Editor*)

HILGER AND WATTS. 1960. 333 PP. £3

THIS combined effort by members of the Spectrometry and Electronics Group of Southampton University presents a substantial framework of basic electronic theory applied to amplifier systems and power supplies normally met in spectroscopy. Theory is reinforced by practical examples in the text and by a chapter of hints on fault-finding. A survey of sources of noise generation is comprehensive and again essentially practical. Later sections cover a medley of topics, such as detectors, with special emphasis on photoemissive devices, the presentation of spectra on cathode-ray tubes, and polarized-beam techniques.

Some criticism should be made that, among the amplifiers discussed, the chopper amplifier is omitted, apart from a brief admission of its advantages in small-signal detection in conditions of slow drift. All the circuit diagrams of power supplies show the reference tube in series with the feedback amplifier, a practice not recommended for conditions of highest stability. The contents would more justify the title page had some of the later chapters been replaced by an account of transistor circuit theory and practice.

The book is not intended as a reference work on the association of electronics with spectroscopy. However, for the spectroscopist, who should be familiar with standard and modern electronics, there is sufficient theory to stimulate further interest and a good practical outlook to appeal to a wide range of spectroscopists.

H. BISBY

FEEDBACK CONTROL SYSTEM ANALYSIS AND SYNTHESIS

J. J. D'AZZO and C. H. HOUPIS

McGRAW-HILL. 1960. 580 PP. £5 4S. 6D.

AT first sight, this book is another rehash of the same old stuff. The first sentence is even more unpromising: 'To a great extent the art of automatic control systems dominates the way of life of modern America and can be considered to act as a catalyst in ensuring the peace or destruction of the world.' The next ten lines continue in like vein of political gesture, after which we get down to our subject.

In spite of this gaffe, the authors did have a serious purpose in writing the text. They were concerned to ease the path of the student, and to this end they have reordered the presentation of the material into what, on the face of it, is a more satisfactory arrangement. The essence of this 'new deal' is to give differential equations a real explanation before dissolving them in the acid of the Laplace transform table; to deal with operational-calculus ideas before mentioning frequency response; and even to cover the use of transient modes and their relationship to the root-locus method before descending to the use of $j\omega$. This is all to the good, and incidentally the order in which the topic is often taught here.

In the whole work (chapter 1 apart!) there is a general emphasis, and a wide range is covered in a modest-sized volume by dealing with major aspects of the subject and giving references for further reading. Also, a few unexpected plums are thrown in for good measure: an interesting section entitled 'Optimum response', one on analogue computers and a final chapter on experimental and design procedures. Appendixes include a few extras as well, notably an ingenious method of automatic root-locus plotting.

In conclusion—this publication contains more or less the standard material, if a rather wider range of it than usual, but with a better ordering of that material and a difference in presentation. J. H. WESTCOTT

ELECTROMAGNETIC FIELDS, ENERGY, AND FORCES

R. M. FANO, L. J. CHU and R. B. ADLER

NEW YORK: JOHN WILEY. LONDON: CHAPMAN AND HALL. 1960. 520 PP. £4 16S.

HERE is another volume in the new-look 'core-curriculum' series sponsored by the Massachusetts Institute of Technology. Like the others, it gives priority to the principles and the analysis of a subject rather than to its technologies.

Although the content covers the ground to be expected, its orientation has points of originality. The emphasis is on electromagnetic fields on the macroscopic scale, but the text goes further than is usual into the relations between circuits and the fields of which they form the configuration, and deals more comprehensively with energy and force principles. Significant is the introduction to the tensor analysis of fields. The book thus achieves a modern, as contrasted with a classical, touch.

It does not shun mathematical aids; but it has, perhaps, rather more elucidatory and explanatory material to make the mathematical implications more clear. Directed specifically to students with what the authors appear to think is a modest knowledge of mathematics, the work gives an early chapter on vector analysis, and its field treatment freely uses both cylindrical and spherical co-ordinates as well as the more familiar Cartesian. Again, H rather than B is chosen as the fundamental magnetic vector, with B and its counterpart D regarded as having little physical significance though mathematically convenient. This is an arguable point of concept, perhaps.

The publication does not make 'easy' reading, but it would be helpful to the student engineer in his pre-graduation year if he were studying at a seat of learning enlightened enough to provide time for relaxed private reading and for discussion with tutors. A sound understanding of field principles (though not much technology) would be his reward. M. G. SAY

IONIZATION PHENOMENA IN GASES

G. FRANCIS

BUTTERWORTH. 1960. 300 PP. £3

IN this volume the author very well meets his declared aim of providing a text for the student who is embarking on postgraduate research in gaseous discharges. It is really two books within the one cover.

In the first four chapters, there is a survey of discharge physics as known at present. This is a very wide field, and the author has made a commendable effort to summarize it, but the style of these sections is concise to the point of requiring some previous background on the part of the reader, if he is to recognize fully the significance of the material presented in the chapters on fundamental processes, the similarity principle, and alternating and high-frequency discharges. This is a necessary consequence of the target aimed at by the author—the postgraduate student—who must be assumed to have had some instruction in the basic physics involved, but otherwise it presents the reader with a condensation of material that would be difficult to appreciate at its full value.

In the second part, with sections on ionization and excitation in the upper atmosphere, high current discharges and thermonuclear effects, and plasma oscillations and waves, the author gives a most interesting and readable account of the applications of discharge theory to the more recent and very exciting developments in discharge physics.

This, then, is a work in two parts. The first can be thoroughly commended to all who are entering on research in gaseous discharges, although it does require some previous knowledge of the subject. The second part differs in style, and provides an excellent introduction to the new fields now being developed, and one which would be appreciated by all those whose interests contribute to developments in the thermonuclear field.

The book is printed in the clear style and with the excellent diagrams associated with its publishing house, and can be commended to all whose interests lie within the sphere of discharge physics. F. M. BRUCE

HYDROMAGNETIC CHANNEL FLOWS

L. P. HARRIS

NEW YORK: JOHN WILEY. LONDON: CHAPMAN AND HALL. 1960. 90 PP. 22S.

THIS book studies turbulent flow of an electrically conductive fluid in a transverse magnetic field and is of interest chiefly in relation to the design of electromagnetic pumps for conducting fluids and possibly in plasma studies connected with the fusion reactor. It is a specialist text based on a doctor of science thesis submitted to the Massachusetts Institute of Technology.

An analysis is given for the case of turbulent flow of a conducting liquid between infinite parallel plates in the presence of a d.c. field; this is extended to the case of a travelling magnetic field, as occurs in induction pumps, laminar flow also being considered in these conditions.

A 'semi-empirical' treatment is employed, based on the use of the basic hydromagnetic equations and on dimensional-analysis techniques, as employed in the analysis of turbulent hydrodynamic flow. It also relies heavily on the results of two tests of experimental data of Hartman and Lazarus (1957) and Murgatroyd (1959). The object of the work is to show the relation between the two sets of data, to provide an understanding of the mechanisms involved in magnetic interactions with flow, and to provide information for designers.

Designers of electromagnetic pumps will welcome the results of this paper, which confirm their usual assumptions that flow losses in a.c. pumps can be determined as though the field were d.c. and that, in general, the effects of the magnetic field on hydraulic losses are insignificant.

It is unfortunate that an analysis of the combined electromagnetic/hydrodynamic problem is complex and involves the use of innumerable symbols. The author would have been well advised to present a complete list of symbols, either for the whole publication or for individual chapters. Without these, the volume is very difficult to use for reference purposes.

L. R. BLAKE

ANALOG COMPUTATION

A. S. JACKSON

McGRAW-HILL. 1960. 652 PP. £5 4S. 6D.

IN the 14 chapters, a comprehensive account is presented of the general-purpose analogue machine—its components, capabilities, and programming techniques. The presentation is such as to be suitable for the reader with no appreciable electronic background. Basic concepts are first outlined, then expanded in further sections to give finally an almost exhaustive treatment of the topic. The book is in fact designed for use by students at about graduate level. While the emphasis is on problem setting-up, uses, and programming of analogue computers, sufficient technical detail of the components is given to facilitate a full comprehension of the various operations.

Three chapters, 8, 9 and 10, deserve special mention: in the first is considered the application of the analogue machine to solving partial differential equations, reduction to appropriate finite-difference equations being necessary when the equation variables are found to be inseparable; chapter 10 discusses 'algebraic matrix models', and in particular how to obtain a stable computer set-up for their solution; and in chapter 11 it is considered how the problem of maximization (or minimization) of a given function, subject to various constraints on the function variables, may be dealt with using the analogue computer.

The text is nicely concluded with a section giving a summary of digital techniques applied in and to analogue computation: included here is a brief description of the so-called 'digital differential analyser' machine. While in earlier sections the author has given comparisons, where appropriate, of the relative merits of analogue- or digital-computer solutions, it is disappointing that the computing capabilities of, and techniques in using, the above-mentioned machine are not now compared with those of purely analogue and purely digital machines.

The author points out that it is necessary for the user to have a working knowledge of the components in order to be able to make correct and efficient use of an analogue machine. Thus, in respect of computer elements, components, and circuit techniques, the accounts given are only such as to allow the reader an understanding of the basic principles involved; most of the computing circuits described are in fact to be found elsewhere, in other works on the subject, being typical of those in present-day large-scale analogue machines. However, as a treatise on the use and application of the analogue computer, the volume is outstanding.

M. J. SOMERVILLE

NUMERICAL METHODS FOR HIGH SPEED COMPUTERS

G. N. LANCE

ILIFFE. 1960. 166 PP. £2 2S.

IT has become fashionable to include in the preface to a new volume some *raison d'être*. Dr. Lance takes the position that his is the first book which has 'the needs of the user of an automatic high-speed computer directly in mind'. Unfortunately, this statement is misleading, since a flood of works on this subject have appeared during the past five years, and most of them have made the same claim.

The reason for this sweeping assertion becomes evident on reading the text: it enables the author to skip lightly over those parts of the topic which, presumably, do not interest him and generally to avoid the necessity for giving detailed proofs. Unfortunately, the result is a publication which is likely to be incomprehensible to the novice.

From the point of view of the more expert reader, the situation is hardly different, because the author follows what can only be described as well trodden paths. For example, it would have been interesting to have had presented a critical appraisal of the relative merits of the Lanczos, Givens, and Householder methods for the determination of latent roots and vectors of a matrix, whereas the method selected as 'best' (that of Lanczos) is derived so badly as to be almost incomprehensible.

These general criticisms, and the high price, make it impossible to recommend the book.

A. D. BOOTH

TRANSFORMERS AND GENERATORS FOR POWER SYSTEMS

R. LANGLOIS-BERTHELOT

MACDONALD. 1960. 541 PP. £3 5S.

THIS eminent French electrical engineer's volume contains two books, one dealing with transformers and the other with the synchronous machine.

Although the preface states that the publication is for the engineering student who has a genuine knowledge of physics, for the engineer concerned with specifications and for the operating engineer, it also collects together the range of basic theory, and full operating conditions, that give an excellent full measure of information for all engineers concerned with large power systems.

There is much cross-referencing to the author's earlier text on electromagnetic machines, which apparently is a more theoretical treatment of the subjects.

The scope of the coverage of each book amounts to an encyclopaedia of the topics, and there is a useful over-all survey of the whole. In general terms, each detail is treated comprehensively. There are valuable reviews of transformer and synchronous-machine insulation problems in the separate parts. Both parts of the volume include a chapter giving guidance to the operating engineer, but in other sections there is a deal of operation guidance, such as the 'preventive medical' programme for the maintenance of stator insulation on p. 385. Transient and stress conditions and other effects are dealt with admirably. A fair proportion of each part provides references to various papers on the subject, but concentrated over the last ten years.

The work leaves out, deliberately, minor details of construction, dimensions, workshop practice, etc., required by the design-office specialist, and also omits many of the finer points introduced by competitive manufacturers, which give rise to improvements in design. Undoubtedly, however, this is an excellent work by a very experienced engineer, of great value to students and to engineers engaged with large power systems who wish to keep abreast of the advances in transformers and synchronous machines over the last ten years.

F. BARRELI.

ELECTRONIC BUSINESS MACHINES

J. H. LEVESON (*Editor*)

LONDON: HEYWOOD. 1959. 272 PP. £2 5S.

THIS is a book of real value to those who have to take decisions, or give advice, on the introduction of electronic data-processing systems to industry or commerce. It is based on lectures given at Dundee Technical College. The divided authorship results in some gaps in the treatment, but it offers the advantage that each contribution displays first-hand experience.

In a good review of programming and preparation of flow charts, many of the attributes and limitations of computers are revealed, and then the important techniques of sorting, labelling or coding of data for storage and retrieval, and dealing with errors are discussed. Some of the major units are described from the user's point of view—input and output equipment, punched cards, magnetic tape, and the transmission of data from outstations.

40% of the text is given to the factors which affect management—the interaction between the new system and the existing organization, staffing, finance and auditing. Much of this is based on American experience; because of the greater readiness there to use and experiment with computers, this is of special value. But alas! the English is deplorable, and the reader has to pick his way through a morass of words.

H. McG. ROSS

AUTOMATIC TRANSLATION

D. Y. PANOV

PERGAMON PRESS. 1960. 73 PP. 21S.

WESTERN workers were first acquainted with the activities of their Russian colleagues in the field of machine translation when I. S. Mukhin presented his paper on the subject before this Institution in 1956. The present volume contains the first full account of subsequent Russian activity to appear in English.

It contains introductory chapters on the history of 'MT' and on the structure and function of the BESM computer which is used at the Institute of Precise Mechanics, Moscow, for translation experiments. These are followed by sections on dictionary construction and on the detailed translation programmes. There is a speculative chapter on the problems which will be encountered in translating such languages as Chinese and finally a detailed example of an English–Russian translation.

It is pleasant to record that the book is most clearly written and that the translating and editing are excellent. It can be thoroughly recommended to specialist and layman alike.

A. D. BOOTH

PRINCIPLES OF SERVOMECHANISMS

A. TYERS and R. B. MILES

PITMAN. 1960. 176 PP. 25S.

THIS book does not pretend to be a thorough treatment of servomechanisms, and it aims at readers without a background of mathematics. Partly for this reason, the essential principles are inadequately covered, and the volume cannot be recommended to any engineer capable of becoming a Corporate member of this Institution.

Some principles are demonstrated by simple examples, but there are important gaps, such as the effect of exponential time delays, integration and phase advance. Only position controls are considered, and the authors miss the opportunity to show the same principles in other fields, e.g. stabilized power supplies.

Nearly 90% of the text deals with the technique and components used in servomechanisms, so that a more apt title would be 'Practice in position servomechanisms'. Separate chapters discuss magnetic, valve, rotary and transistor amplifiers and give practical data with examples of circuitry. The brief treatment of these subjects covers only salient features and would be improved if the further references on p. 174 were associated with the appropriate topics. A. ASBURY

ANNOUNCEMENTS TO MEMBERS

THE HOMES FUND

SUMMARY OF CONTRIBUTIONS RECEIVED TO 9TH JULY 1960

	No. of contributors	£	*s.*	*d.*
£1000 and over	8	8685	0	0
£100 to <£1000	32	7181	3	0
£5 to <£100	916	9560	9	3
£2 to <£5	2269	6247	6	7
under £2	28998	15174	5	2
		£46848	4	0

APPOINTMENTS AND NOMINATIONS

JOINT I.MECH.E./I.E.E. COMMITTEE ON MODEL FORMS OF GENERAL CONDITIONS OF CONTRACT, AND COMMITTEE ON MODEL FORMS OF GENERAL CONDITIONS OF CONTRACT (ELECTRICAL)

ON the nomination of the British Transport Commission, the Council have appointed Mr. S. C. Robbins to succeed Mr. J. A. Broughall, B.SC.(ENG.), MEMBER, on the above-named committees. (The Council of The Institution of Mechanical Engineers have approved Mr. Robbins's appointment to the joint committee.)

JOINT COMMITTEE ON THE APPLICATIONS OF ELECTRICITY IN AIRCRAFT

On the nomination of the Air Ministry, the Council have appointed Wing-Cmdr. I. Roberts to serve on the above committee as the Ministry's second representative.

OVERSEA REPRESENTATIVE IN PAKISTAN

The Council have appointed Mr. H. L. Jefferies, ASSOCIATE MEMBER, their Oversea Representative in Pakistan in succession to Mr. A. E. C. Gibson, MEMBER, who left Pakistan on the 1st July 1960.

B.S.I. CODE OF PRACTICE COMMITTEE ON THE USE OF TRANSISTORS AND RELATED SEMICONDUCTOR DEVICES—ELCP/29

The Council have nominated Mr. T. R. Scott, D.F.C., B.SC., MEMBER, to serve as their representative on the above committee.

B.S.I. TECHNICAL COMMITTEE INE/8—REVOLUTION INDICATORS AND RECORDERS SUB-COMMITTEE INE/8/1—MECHANICAL AND MAGNETIC REVOLUTION INDICATORS AND RECORDERS SUB-COMMITTEE INE/8/2—ELECTRICAL ASPECTS OF REVOLUTION INDICATORS AND RECORDERS

The Council have nominated Mr. P. Smith, B.SC., MEMBER, to serve as their representative on the above committees in place of Mr. W. Bamford, B.SC., MEMBER, who expressed a wish to be excused from further service.

B.S.I. SUB-COMMITTEE ELE/3/28—FLEXIBLE CORDS FOR PORTABLE APPLIANCES

The Council have nominated Mr. R. A. Marryat, B.SC.(ENG.), MEMBER, to serve as their representative on the above new sub-committee.

JOINT BRITISH COMMITTEE FOR STRESS ANALYSIS

The Council have nominated Dr. J. S. Forrest, M.A., MEMBER, with Mr. N. Kerruish, M.A., ASSOCIATE MEMBER, as his deputy, to serve as their representative on the above committee.

NATIONAL SOCIETY FOR CLEAN AIR—EXECUTIVE COUNCIL

The Council have nominated Mr. A. R. Cooper, M.ENG., MEMBER, to serve as their representative on the above council in place of Mr. C. T. Melling, C.B.E., M.SC.TECH., VICE-PRESIDENT, who has resigned.

BIRMINGHAM TECHNICAL COLLEGES—ELECTRICAL ENGINEERING ADVISORY COMMITTEE

The Council have nominated Mr. L. L. Tolley, B.SC.(ENG.), MEMBER, to serve as their representative on the above committee.

CROYDON TECHNICAL COLLEGE—GOVERNING BODY

The Council have nominated Mr. F. J. Lane, O.B.E., M.SC., MEMBER, to serve as their representative on the above governing body.

RUGBY COLLEGE OF ENGINEERING TECHNOLOGY—GOVERNING BODY

The Council have nominated Mr. L. Drucquer, MEMBER, to serve as their representative on the above governing body.

AWARD OF PREMIUMS

THE Council have awarded the following premiums for papers read or accepted for publication during 1959:

GROUP A

The Institution Premium (value £50)
No award

The Kelvin Premium (value £25)
E. P. Butt, B.SC., R. Carruthers, B.SC.(ENG.), J. T. D. Mitchell, B.SC.(ENG.), R. S. Pease, P. C. Thonemann, M. A. Bird, B.SC., J. Blears, B.SC.(ENG.), and E. R. Hartill, B.SC.(ENG.) — 'The design and performance of Zeta'

The John Hopkinson Premium (value £25)
D. A. Barron, M.SC. — 'Subscriber trunk dialling'

GROUP B

Electronics and Communications Section Premiums

The Duddell Premium (value £20)
G. B. B. Chaplin, M.SC., PH.D., and A. R. Owens, M.SC. — 'A method of designing avalanche transistor trigger circuits'
G. B. B. Chaplin, M.SC., PH.D., A. R. Owens, M.SC., and A. J. Cole, B.SC. — 'A sensitive transistor oscillograph with d.c. to 300 Mc/s response'

The Ambrose Fleming Premium (value £15)

A. E. Karbowiak, PH.D., B.SC.(ENG.), and V. H. Knight	'An experimental investigation of waveguides for long-distance transmission'

Premiums (value £10 each)

A. H. W. Beck, M.A., B.SC.(ENG.)	'High-current-density thermionic emitters: a survey'
Prof. A. L. Cullen, PH.D., B.SC.(ENG.)	'Theory of the travelling-wave parametric amplifier'
L. Lewin	'The efficiency of a ferrite as a microwave mixer' 'A ferrite boundary-value problem in a rectangular waveguide' 'Phase measurements through tapered junctions'
G. Craven and V. H. Knight	'The design and testing of integrally constructed waveguide assemblies'
R. Beaufoy	'Transistor switching-circuit design using the charge-control parameters'
H. A. C. Hogg, B.SC.	'Periodic electrostatic beam focusing'

Measurement and Control Section Premiums

The Silvanus Thompson Premium (value £20)

L. Essen, O.B.E., D.SC., PH.D., F.R.S., E. G. Hope, B.SC., and J. V. L. Parry, M.SC.	'Circuits employed in the N.P.L. caesium standard'
L. Essen, O.B.E., D.SC., PH.D., F.R.S., J. V. L. Parry, M.SC., and J. McA. Steele, B.SC.(ENG.)	'Frequency variations of quartz oscillators and the Earth's rotation in terms of the N.P.L. caesium standard'

The Mather Premium (value £15)

W. K. Taylor, B.SC., M.SC., PH.D.	'Pattern recognition by means of automatic analogue apparatus'

Premiums (value £10 each)

A. M. Thompson, B.SC.	'The cylindrical cross-capacitor as a calculable standard'
O. P. D. Cutteridge, M.SC.(ENG.)	'The stability criteria for linear systems' 'Some tests for the number of positive zeros and for the numbers of real and complex zeros of a real polynomial'

Supply Section Premiums

The Sebastian de Ferranti Premium (value £20)

T. H. Mason, P. D. Aylett, PH.D., M.SC.(ENG.), and F. H. Birch, B.SC.(ENG.)	'Turbogenerator performance under exceptional operating conditions'

The John Snell Premium (value £15)

J. S. Forrest, M.A., D.SC., P. J. Lambeth, B.SC.(ENG.), and D. F. Oakeshott, B.SC.	'Research on the performance of high-voltage insulators in polluted atmospheres'

Premiums (value £10 each)

F. S. Fay, M.A., J. A. Thomas, B.SC., D. Legg, B.SC., and J. S. Morton, B.SC.	'Development of high-voltage air-break circuit-breakers with insulated-steel-plate arc chutes'
T. R. Manley, B.SC., K. Rothwell and W. Gray	'The application of low-pressure resins to some high-voltage switchgear designs'

Utilization Section Premiums

The Crompton Premium (value £20)

M. C. Crowley-Milling, M.A.	'The application of irradiation in industry'

The Swan Premium (value £15)

D. B. Corbyn, B.SC.(ENG.), and N. L. Potter, B.SC.(ENG.)	'The characteristics and protection of semiconductor rectifiers'

Premium (value £10)

E. Jacks	'Discrimination between h.r.c. fuses'

Non-Section Premiums

The Ayrton Premium (value £20)
No award

The Llewellyn B. Atkinson Premium (value £15)

C. J. Carpenter, M.SC.(ENG.)	'Surface-integral methods of calculating forces on magnetized iron parts'

GROUP C

The Blumlein–Browne–Willans Premium (value £20)
No award

The Frank Gill Premium (value £15)
No award

The Heaviside Premium (value £15)

P. R. Bryant, M.A., M.SC.	'The order of complexity o electrical networks'

Oversea Premiums

For senior members (value £15)

S.-Y. King, B.SC.(ENG.), PH.D.	'The electric field near bundle conductors'

For Students and Graduates under 28 years of age (value £10)
No award

Graduate and Student Premiums

Premiums (value £10 each)

R. Hawley, B.SC.	'Vacuum as an insulator'
P. Powers, B.SC.	'Ultra-high-frequency tetrodes'

Premiums (value £5 each)

B. G. Cryer	'The rising service'
K. Gunary	'Fundamentals of a.c. railway traction rectifier equipments'
G. L. Horrobin and A. D. Hawkins	'The magnetic amplifier'
J. M. Walker	'Fully automatic aircraft landing approach'
M. H. Walshaw, B.SC.(ENG.)	'Railway signalling'

Letters of Commendation

J. R. Anderson and A. B. Dobie	'Moisture detection in insulation by the measurement of dielectric dispersion'
G. Bors	'Technical education in Hungary'
W. Fong	'Speed-changing of 3-phase squirrel-cage induction motors by pole-amplitude modulation'
T. R. Forfod, B.SC.	'Hydroelectric power in Norway'
G. W. Green	'The development of city distribution systems'
P. J. G. Hetzel, M.SC.	'Aerial by aerials—radio in the service of the pilot'
A. D. Swanston, B.SC., and B. W. Towell	'Diesel railway locomotives'

PRIZES FOR NATIONAL CERTIFICATE STUDENTS

As briefly reported in the July 1960 *Journal*, p. 435, the Council of The Institution have agreed to the establishment of an annual prize for the best Higher National Certificate student who takes electronics or telecommunication subjects in his final examination. The award, which will be known as the Goldup Prize, has been endowed by Mullard Ltd. as a memorial to the life and work of the late T. E. Goldup, a Past-President of The Institution, who took a keen and extremely active interest in electrical engineering education.

As a consequence of the establishment of the Goldup Prize, the existing Page Prize will in future be awarded to the corresponding Higher National Certificate student who has taken electrical power subjects in the final examination.

CONFERENCE ON NON-DESTRUCTIVE TESTING

A CONFERENCE on non-destructive testing, to be held in November 1961, was announced in the March 1960 *Journal*, p. 187. The scope of the subject is wide—as is shown by the list of suggested topics in that announcement—but, for the

purpose of The Institution's conference, topics will be excluded which might more appropriately be considered by mechanical engineers. This conference is quite independent of the one on electronic components and materials, to be held in June 1961.

It is possible that the Organizing Committee, being finite in numbers and in fields of experience, have overlooked some part of the subject, so that, although a number of papers are known to be in preparation, the Committee invite offers of further papers on any topics which the prospective authors consider relevant.

The date by which papers should be completed is May 1961, but if intending authors will begin by sending short résumés of their proposed papers, the Committee will warn them at an early stage of other papers covering the same ground, or advise them if the topic is not considered to fall within the scope of the conference. If such résumés are received by mid-October 1960, it will help the Committee in planning the programme of the conference.

ELECTRIC TRACTION HISTORY

THE Light Railway Transport League are planning to have reprinted the electric railway number of *Cassier's Magazine* of August 1899. The 300 pages of this issue contain articles by F. J. Sprague, P. V. McMahon and others on the history and development of electric traction up to that time.

Further information may be obtained from the Honorary Treasurer of the Light Railway Transport League, 245 Cricklewood Broadway, London N.W.2.

COURSE FOR TECHNICAL REPRESENTATIVES

A PILOT course for technical representatives was arranged in September 1959 by the Department of Industrial Administration of the College of Advanced Technology, Birmingham.

The success of this course encouraged the college to run another, which will begin on the 26th September 1960.

The course is for people who are engaged in technical sales activities etc. and is full-time for six consecutive weeks. The number of participants is restricted to 12, and the fee is 60 guineas for each course member. Further particulars may be obtained from W. J. Williams, Department of Industrial Administration, College of Advanced Technology, Gosta Green, Birmingham 7.

RAILWAY ELECTRIFICATION EXHIBITION

NEW electric locomotives, rolling-stock and a.c. electrification equipment built for British Railways are to be displayed at Battersea Wharf, near Chelsea Bridge, London, from the 3rd to 9th October 1960.

The exhibition is being organized by the Locomotive and Allied Manufacturers' Association of Great Britain and the British Electrical and Allied Manufacturers' Association in co-operation with the British Transport Commission. It will coincide with the British Railways Electrification Conference in London.

ULTRASONIC INSPECTION

A CONFERENCE on the theory and practice of ultrasonic inspection is to be held at the Queens Hotel, Cheltenham, from the 22nd to 24th September 1960. The arrangements are being made jointly by The Institute of Physics Non-Destructive Testing Group, The Society of Non-Destructive Examination, and The Non-Destructive Testing Society of Great Britain.

Further details may be obtained from the Conference Secretary, Mr. I. M. Barnes, Materials Laboratory, de Havilland Propellers Ltd., Hatfield, Herts.

Contents of the current *Proceedings*

The date in italics is that of the Journal review, special article, or synopsis. Where given, the date in capitals is the month in which a paper or monograph was published individually

PART A. POWER ENGINEERING (AUGUST 1960)

J. H. GRIDLEY, PH.D., B.SC.(ENG.). PAPER 3172S, JANUARY 1960 **Shielding of overhead lines against lightning** *April 1960*

H. J. H. SKETCH, B.SC.(ENG.), P. A. SHAW, B.SC.(ENG.), *and* R. J. K. SPLATT. PAPER 2955M, JUNE 1959 **New method for observing the phenomena of commutation** *April 1960*

K. F. BACON. PAPER 3266U **Transistorized regulation and control of aircraft electrical power systems** *July 1960*

Communicated discussion on **Applications of electricity in aircraft**

D. H. GRINDELL, PH.D., B.SC.(ENG.). PAPER 3184S, JANUARY 1960 **Electrostatic dust monitor** *June 1960*

D. CONNELLY, B.SC. PAPER 3280M **Two-phase induction motor used as a servomotor** *July 1960*

Discussion on **Engineering education at the technical universities in Western Germany** before the Sheffield Sub-Centre

G. CAMILLI. PAPER 3288S **Gas-insulated power transformers** *July 1960*

L. R. BLAKE, PH.D., B.SC. PAPER 3278M **Resistivity monitor to indicate oxide content of sodium** *August 1960*

Discussion on **Selection of insulation levels and tests for high-voltage transformers** before the North-Western Supply Group and the North Staffordshire Sub-Centre

Discussion on **Electrification of the U.K.A.E.A. Industrial Group factories** before the South Midland Centre

Discussion on **The *Deltic* locomotive** before the Western Utilization Group, the South Midland Centre and the Tees-Side Sub-Centre

Discussion on **Investigations of power-follow-current phenomena using a synthetic power source** and **Impulse initiation of arc discharges** before the North Midland Centre

Communicated discussion on **Performance of displacement governors under steady-state conditions**

PART B. ELECTRONIC AND COMMUNICATION ENGINEERING (JULY 1960)

See the Journal for July 1960, p. 452

PART C. MONOGRAPHS (MARCH 1960)

See the Journal for March 1960, p. 183

OVERSEA ATTENDANCE REGISTER

DURING the period 20th June to 15th July 1960, these members called at the Institution building and signed the Attendance Register of Oversea Members:

BARTHOLOMEW, B. C. (Lagos, Nigeria)
BEESLEY, W. (Livingstone, N. Rhodesia)
BLAMIRE, J. (Kuwait)
BOZZOLI, G. R. (Johannesburg)
FERNANDO, W. G. A. (Colombo, Ceylon)
FORD, W. P. (Lusaka, N. Rhodesia)
GOODISON, H. (Lagos, Nigeria)
HARGREAVES, H. R. (Bogotá, Colombia)
LEICESTER, W. L. (San Fernando, Trinidad)
MANASSEH, B. (Butterworth, Malaya)
NAYER-NOURI, H. (Tehran)
NEWMAN, P. L. (Johannesburg)
SAVVA, G. (Limassol, Cyprus)
STEVENS, F. (Ladysmith, Natal)
STRAWSON, T. R. (Johannesburg)
THRUPP, F. E. M. (Rome)

News from the Centres

MERSEY AND NORTH WALES CENTRE

Summer Meeting

THE Summer Meeting on Saturday, 21st May 1960 combined a tour of the works in progress of the hydroelectric pumped-storage scheme at Blaenau Ffestiniog, and of the nuclear power station at Trawsfynydd. The journeys to and from Blaenau were made by special Diesel train from Birkenhead, with Mr. and Mrs. T. A. P. Colledge and other members joining at Chester, making the party up to nearly 100.

On arrival, our hosts, the Central Electricity Generating Board, took control, their first care being entertainment to lunch in the canteen on the site of the power station. Mr. W. H. C. Pilling, chief project engineer of the North Project Group of the Board, received the visitors; and members of his staff, together with some of the contractors' staff, kindly acted as guides.

Following lunch, we were taken by coach on a most spectacular and seemingly hazardous ascent of 1000ft, with severe gradients and hairpin bends, to the upper reservoir at Llyn Stwylan. The skill of the truck drivers holding their heavy vehicles on this difficult circuit fully merited the admiration aroused. After viewing the lower dam and power station, a journey was made by coach to the site of the nuclear power station at Trawsfynydd.

Many of us had been here on the occasion of a visit to the hydroelectric works at Maentwrog and inspected the dam forming the artificial lake, which now is to provide cooling water for the new station—as yet the only nuclear station to have an inland-water supply.

Buffet tea was provided at Trawsfynydd by the C.E.G.B. before we were taken to see the construction works.

The generous hospitality of the C.E.G.B. and the attentions of Mr. Pilling and those who gave their leisure to help him, all in perfect weather, combined to make a very good day.

Golf tournament

We were indebted to the members and committee of the Southport and Ainsdale Golf Club, who once more placed their course at our disposal. The competition was played in glorious sunshine on Tuesday, 21st June 1960; and, with scoring by the Stableford method, remarkably close finishes resulted.

The G.P. Dennis Challenge Trophy and replica, restricted to Institution members, was taken by Mr. J. S. Ekbery with a score of 38 points, and he has established a record of four wins—the earlier years being 1950, 1952 and 1958.

Mr. Wallwork won first prize in the over-14-handicap open singles competition, after a tie with Mr. J. M. Christie. Mr. G. Baker, a previous winner of the under-13 singles, had a good day, as he tied for second place in this event, and with Mr. A. Josey as partner won the greensome competition after a tie with Messrs. H. Brown and N. Fitzsimmonds.

The arrangements were capably handled by Mr. G. L. Simpson with assistance from the experienced Mr. F. J. Brown.

Annual Dinner

The Annual Dinner will be held on Monday, 7th November 1960 at the Adelphi Hotel, Liverpool. E. W. A.

Mersey and North Wales Centre Summer Meeting
Some of the party at the Blaenau Ffestiniog hydroelectric power station

TEES-SIDE SUB-CENTRE

Larger attendances

WE were very pleased to welcome the North-Eastern Centre Chairman, Mr. H. Watson-Jones, on the 6th January 1960, when he repeated his Chairman's Address in which he recounted the development of electricity generation and distribution from the end of the last century to the present day and concluded by giving us a glimpse of the future in a description of the nuclear power station now being constructed at Trawsfynydd in North Wales. Also on view at this meeting was the carved attendance-register desk which we joined with our parent Centre in presenting to The Institution to mark the Centre's Diamond Jubilee.

It is gratifying to be able to report continued improvement in attendances at Sub-Centre meetings during the latter half of the 1959–60 Session, a striking example being the record attendance of 89 to hear the Second Hunter Memorial Lecture by Mr. H. G. Bell on the 3rd February 1960.

There was also a large attendance on the 2nd March to hear Mr. C. M. Cock's paper 'The *Deltic* locomotive', when we had the pleasure of the company of many local members of The Institution of Mechanical Engineers, who added considerably to the interesting discussion which followed.

Members of the Sub-Centre have noted with pleasure the successes of students attending Constantine Technical College, Middlesbrough, in the 1959 Higher National Certificate and Diploma examinations. Out of a total of 46 prizes awarded by The Institution over the whole country for high over-all marks, six were to students of this college. A letter of congratulation has been sent to the Principal.

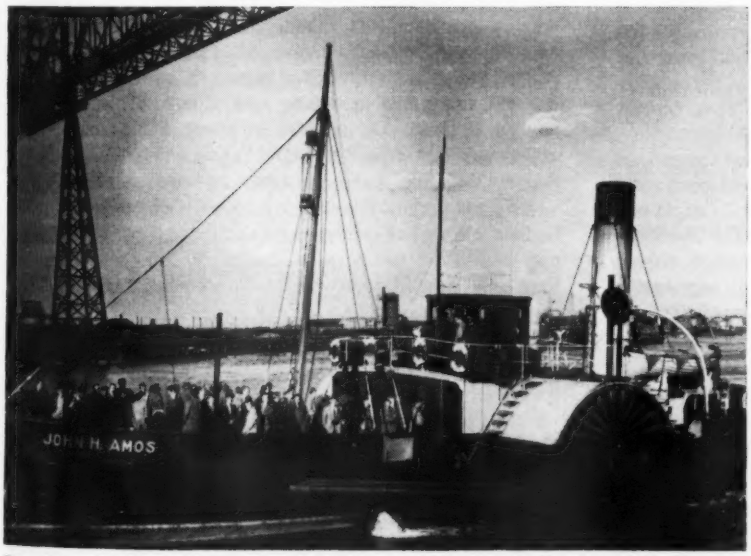
Visits

On the 14th May, a coachload of members and friends visited the Tyne Tees Television studios in Newcastle, and Stella South power station. The decision to invite ladies met with a good response. Apart from a minor cloudburst at tea-time, which embarrassed one or two coatless optimists, this double visit seems to have been enjoyed by everyone, and will give encouragement for arranging similar functions in the future.

An evening visit to the Middlesbrough Telephone Exchange was made on the 21st June. This exchange is one of the most modern in the country and will give subscriber-trunk-dialling facilities at the end of 1960; as was expected, the visit proved most interesting and instructive.

At the time of writing, we are looking forward to the evening of the 14th July, when 40 of our members will have an excursion by tug down the River Tees, by courtesy of the Tees Conservancy Commission. Undeterred by the ruling that no alcoholic refreshments or ladies may be taken aboard, this expedition has been heavily oversubscribed. A running commentary has been promised on the many points of interest to be seen during the two-hour trip down this heavily industrialized and historic estuary [see photograph].

A further innovation occurred in April, when the Graduate and Student Section organized an exhibition in Middlesbrough, to which senior members were also invited. Although primarily intended to show equipment made by our Graduates and Students, several manufacturers brought along a varied selection of exhibits to add to the interest and scope. The exhibition proved to be well worth while, and the organizers are to be congratulated on their success. N. M.



Tees-Side Sub-Centre members aboard the paddle tug at Middlesbrough at the start of their river trip on the 14th July 1960

NORTH STAFFORDSHIRE SUB-CENTRE

Faraday Lecture

THE Faraday Lecture 'Electrical machines' was given by Prof. M. G. Say on the 8th March 1960 in the Victoria Hall, Hanley. The hall was filled to capacity by an audience of about 2000. Any doubt there may have been as to whether the subject would appeal to members of the general public was dispelled by the close attention paid throughout to Prof. Say's brilliant exposition and demonstrations and by the ovation given to him at the end.

Before the lecture, in the unavoidable absence of the Lord Mayor, the Deputy Lord Mayor of Stoke on Trent thanked The Institution for the opportunity again given to the people of North Staffordshire to hear the Faraday Lecture. The Chairman, Mr. A. Asbury, briefly referred to the life and discoveries of Michael Faraday and then introduced the Lecturer. A vote of thanks to the Lecturer and his assistants was proposed by the Vice-Chairman, Mr. G. H. Gillam, and the Chairman thanked the Deputy Lord Mayor for the facilities provided by the Stoke on Trent Corporation.

Short papers

On the 21st March 1960, a joint meeting was held at Stafford with the Graduate and Student Section, when three short papers were read by members of the Section. It was appropriate that at this meeting the Chairman formally welcomed Mr. R. B. Larkinson as a Corporate member and mentioned Mr. Larkinson's work as a Past-Chairman of the Section.

Mr. A. Davies read his paper on 'Electric soaking pits', in which he described electric and also combined electric and oil-fired pits for heating steel ingots and discussed the advantages of each type. He dealt with the control systems used and mentioned transformer tap-changers doing 100000 operations per year. Mr. J. R. Spanswick opened the discussion, which was joined by five other members.

The next paper, by Mr. J. H. Smith, reviewed 'Colliery power supplies' and referred to the large supplies now

required by collieries which were being developed to produce 1½ million tons annually and to take all their power from the Electricity Board. During the paper and the discussion, opened by Mr. E. J. Waddon, the limitations of 3·3kV for the colliery distribution system were commented on, and the necessity for supply to be taken at 11kV or a higher voltage to avoid undue voltage fluctuation was stressed.

The third paper, on 'The computer in industry', was read by Mr. E. Hession, who gave an account of the application of a computer to various industrial processes and clerical work. He considered that the full benefit would be obtained only when the machine or clerical process was specially designed to suit computer methods. He also touched on the possible effects on society of the extended use of computers in industry and commerce. An interesting discussion was opened by Mr. T. E. S. Rickard, who spoke about servomechanisms in the application of computers to industrial processes; and, in this connection, his suggestion that man was the cheapest form of servomechanism produced entirely by unskilled labour seemed to be generally accepted.

In proposing a vote of thanks, Mr. H. S. Brown thanked the authors for a most interesting evening and complimented the Section on the wide interests covered by the papers selected. He referred to the great responsibility resting on engineers developing and applying computing equipment, and thought that careful consideration should be given to the social aspects and the effect on people's lives.

District Meeting

A District Meeting on the 11th April 1960 took the form of an afternoon visit to the Kidsgrove works of the English Electric Co. Ltd., followed in the evening by a paper on 'Silicon transistors—their manufacture and fields of application' by Dr. J. T. Kendall. The factory is engaged in the development and manufacture of a wide range of electronic equipment and its application to data-processing and the control of generating plant and motor-driven equipment of all kinds. The visit proved to be most interesting, particularly as it was possible to demonstrate much of the equipment which was being developed.

Dr. Kendall examined the characteristics of and the various methods of manufacturing silicon transistors and contrasted them with transistors of the germanium type. He explained that, on the ground of relative cost, the silicon transistor would generally be used only where the temperature conditions would exceed the maximum 100°C for which germanium was suitable. A considerable number of members and friends joined the discussion, opened by Mr. R. H. Allmark.

A vote of thanks to Dr. Kendall was proposed by Mr. R. W. Conway, who felt sure that both members and visitors had found the topic extremely interesting. He referred to the very fine tolerances permissible in the manufacture of silicon transistors and the great thought which had gone into the development of this field of production. He congratulated the author on making the subject seem so simple and thought this was largely due to his delivery of the lecture entirely without reference to notes.

On behalf of the Sub-Centre, Mr. R. W. Palmer thanked the English Electric Co. Ltd. and the staff of the Kidsgrove works for their hospitality and the excellent arrangements made for the visit. He did not know what the visitors had expected, but he was quite sure the extent and range of the equipment and applications shown and demonstrated had exceeded all expectations. He now wished to join with the boy who, thanking his hostess, said 'Thanks for having us, we've been had very nicely', although he was not quite sure whether that exactly expressed his meaning. L. G.

WEST WALES (SWANSEA) SUB-CENTRE

Summer Visit

THE Summer Visit of the Sub-Centre took place on the 11th June 1960, when a party of 36 visited the British Petroleum Company's new tanker terminal at Angle Bay on the south shore of Milford Haven. The journey to Pembroke was accomplished by car on a warm summer's day, and there, almost under the shadow of the great Norman castle, the Company kindly entertained us with morning coffee, lunch and tea and provided us with transport by coach and boat to view the terminal.

After morning coffee, we proceeded by coach to Pembroke Dock and then boarded *Pembroke Petrel* and *Pembroke Goosander*, two motor launches, and travelled some six miles up the Haven in the face of a fresh breeze and spray which proved most exhilarating to the 'sailors', none of whom suffered seasickness in what was really a sheltered harbour with deep water. On board, members were able to obtain a close view of the jetty under construction, which when completed will berth the biggest tankers now envisaged for discharging crude oil; at the same time, a distant view was obtained of Popton Fort and the tank farm at Kilpaison. After an hour, we were returned to Pembroke for lunch.

Not a drop of oil

During the afternoon, we visited Popton Point, an area which includes Popton Fort and Kilpaison Farm. Popton Fort, built in 1863 but long disused by the War Department, was being adapted as offices, and some old street lamps brought from Chelsea admirably matched their surroundings where they had been erected in the courtyard of the fort. Nearby, we saw the shore installation, with its bunker tanks under construction. The electric pumps were most interestingly housed in a magnificent groined vaulted gallery in the thickness of the old fortifications, where the gun emplacements have now been fronted with fine windows facing the waters of the Haven.

Travelling from the fort along the coastal strip for 1½ miles, we saw the tank farm for the storage of the crude oil, whence it will be carried by a 60-mile pipeline to the Company's refinery at Llandarcy, near Swansea. It was noteworthy that, in the lay-out of the tank farm, steps had been taken to preserve the natural beauty of the countryside, since the area is within one of the Welsh National Parks.

Our visit was well worth while. It is true that we saw not a drop of oil, for the first tanker had not arrived—but there was plenty of water in this splendid setting, the view of which we much enjoyed. A. E.

ORDINARY MEETING

'ANGELS' AT SAVOY PLACE

THE lecture by Dr. E. Eastwood at Savoy Place on the 28th April 1960, with the President in the chair, was of unusual interest, both for the fluency and charm with which it was delivered and for the excellence of the slides and films with which it was illustrated. There was an audience of just over a hundred; but there is little doubt that it would have been far larger had not the Electronics and Communications Section filled the Theatre the previous evening for a lecture on a new system of colour television, complete with demonstrations.

Radio-ornithology

Dr. Eastwood briefly described the high-power L-band radar and P.P.I. presentation with which the observations were made, and proceeded to introduce us to the 'angels', which in technical language are echo returns from unidentified scattering sources in the atmosphere. It was obvious that these are a serious problem in the operational use of radar.

On the other hand, radar is proving a powerful tool for studying 'angels'. It has been known for some time that birds and insects can give radar returns, but, with the advent of high-power radar, the subject of radio-ornithology has taken on a new significance. The lecturer made it clear that, though all birds might be 'angels', he was not prepared to say that all 'angels' were birds, which was a word of caution to the ornithologists in using this new aid to study the migratory habits of birds.

Perhaps the most exciting parts of the lecture were the films speeded up 240 times, so that aircraft darted about with alarming velocities; while the mass migration of birds inwards and outwards, more particularly over the North Sea, dependent on the time and season, was most impressive. During these tests, the high power of the radar was strikingly shown by the 'flash' of noise on the screen as the sun passed through the beam at dawn and at sunset.

A combined exercise

The high spot of the evening was the description of the 'ring angels', which, by a combined exercise of bird and P.P.I. watching, had definitely been identified with the flight at dawn of successive waves of starlings from their roosts. Striking pictures were shown of the assembly and re-entry of the birds at sunset. Many 'ring angels' have been observed; and a tape recording was played demonstrating the noise in the roost, with its sudden drop in intensity as each successive wave 'took off'.

Time was short for discussion, but Maj. M. V. G. Fuge put forward the suggestion that the 'ring angels' might be a refraction effect associated with bubbles of air, formed in hollows in the ground, which expanded with the rapidly changing temperature conditions at sunrise. This led Mr. G. Millington, as a colleague of the lecturer, to disclose some of the fantastic ideas that were put forward in the early days of the investigation, when they were loath to accept the starling hypothesis, though he hastened to say that he had not personally taken part in the dawn observations at the roosts.

In reply, Dr. Eastwood said that he 'would deal with Mr. Millington in the morning'; but in the sequel the latter's inquiry after the meeting whether anyone knew of a good job going for someone of his own age and experience proved unnecessary. Altogether it was a most enjoyable evening; and, in summing up, Sir Willis Jackson voiced the feeling of everyone present in saying that they had heard a delightfully presented lecture of outstanding merit. G. M.

EDUCATION DISCUSSION CIRCLE

The place of illumination

ANY who attended the discussion at Savoy Place on the 29th March 1960, initiated by Mr. G. F. Freeman on the teaching of illumination, were left in no doubt that this was a sadly neglected topic. After his arresting opening statements that the electrical industry owed its early development to its usefulness in the lighting field and that an estimate of the lighting load in Great Britain indicated a possible maximum demand of 4000 MW and an annual consumption of about 4×10^9 kWh, Mr. Freeman showed that the teaching of illumination rested on artistic as well as engineering foundations.

Too many technical-college teachers seldom got beyond defining a few units (usually imperfectly) and calculating illumination values given by a few uniform point-sources. He argued that there should be exercises on line and surface sources and on dimensions of filaments to give specified temperatures; some well directed non-numerical (not woolly-descriptive) studies might not be out of place. Many teachers would find the City and Guilds and the Institution Part III syllabuses in illumination engineering of value in giving them fresh ideas.

Broadening university courses

Prof. H. E. M. Barlow's stimulating examination of university courses in electrical engineering on the 22nd April 1960 at Savoy Place began with the statement that electrical engineering was built on a foundation of physics and this subject must figure largely in the early stages of the curriculum; in fact, science and engineering students could well have a common syllabus for the first two years. The stress on fundamentals should not, however, be allowed to obscure the need for applications as an illustrative aid in lectures.

He felt that specialization in school should be resisted, and the only satisfactory way was to increase the length of the university course to four years, though he saw little likelihood of this happening. It was possible to make more profitable use of undergraduate time by adopting a technique of

unification in the presentation of some of the basic ideas which differed only superficially, as, for example, the principles of oscillations, which can readily be applied to cover all types, both electrical and mechanical.

In the subsequent discussion, no clear answer could be given to the problem of excessive specialization in schools, because university-entrance conditions tended to encourage it. A longer university course found favour with some, and there were many suggestions for the use which should be made of the additional time: mental and moral philosophy and the philosophy of science were some of the advocated subjects. Management was not considered to be a suitable topic, because some industrial experience was required before this was studied. One speaker thought that the final school year could with advantage be handed over to the university as a preparatory year for university life. The value of residential accommodation in helping students to learn from each other was stressed.

Teaching in Sweden

It is unwise for any discussion group on education to be concerned solely with affairs of parochial interest, and it has now become almost standard practice to include a speaker from oversea in the programme of the London Education Discussion Circle. This year, Prof. F. Dahlgren, of the Royal Institute of Technology, Sweden, was invited to describe electrical engineering education at university level in Sweden. At Savoy Place on the 20th May 1960, his fluent delivery, pleasantly interlaced with humour, held his audience captive while he outlined the organizational, staffing and curricula problems. The three essential aims of Swedish engineering education were clearly defined, namely to impart a thorough knowledge of fundamentals; to orientate, emphasizing industrial and economic aspects but avoiding detail; and to give training in scientific work and thinking involving some specialization.

Students enter at the age of about 21 for the four- to five-year engineering course, for which no tuition fees are charged, and they have to be competent in reading English or German. They are expected to average 30 hours' attendance per week, but little check is kept on this. Lectures are used mainly to resolve difficulties; exercises and group discussions are regularly held, and a limited amount of design training is given. In the laboratories, the experimental work is used mainly to confirm the student's previous analysis of the given problem.

Oral and written examinations are held approximately three times per year, and failure means that a subject must be retaken, but the student could earn the title 'der evige student', because there is no limit to the number of retakes. The final-year's diploma project is often undertaken in industry.

Postgraduate work can lead to the degree of technical licentiate (two years' work) or doctor of technology (four years' work). The thesis for the doctor's degree has to be defended in public against three opponents. Two, one appointed by the Institute and the other by the candidate, criticize the thesis from a scientific angle, while the third acts as a kind of court jester and has to make a joke of the whole proceedings. He is selected by the candidate himself, and he should be a great humorist and preferably have no knowledge of the field covered by the diploma. His task is apparently to persuade the audience to remain so that the test can be claimed to be public!

The animated discussion could have left Prof. Dahlgren in no doubt that his journey was worth while and that his English colleagues appreciated his lucid explanation and were keen to profit from Swedish experience. K. R. S.

BULLETIN OF THE SECTIONS

UTILIZATION

USING ELECTRICITY SAFELY

The meeting at Savoy Place on the 5th May 1960, graced by the presence of members' ladies, was the occasion of the Annual Lecture of the Section, given by Mr. S. J. Emerson, who took as his subject 'Safety in the utilization of electricity'. The lecturer, the senior electrical inspector of factories and electrical adviser to the Home Office, was in an authoritative position to deal with this matter, which he covered in a delightfully informative way, laced with many touches of macabre humour when referring to the details of some of the electrical fatalities which have occurred in recent years.

Mr. Emerson gave it as his considered opinion that electricity is now the safest form of both industrial and domestic power, substantiating this with official statistics showing the relationship of the total electrical accidents to the use of electricity over the past 50 years.

Dealing with avoidable accidents, he strongly recommended that the plug should be withdrawn from the socket directly an appliance is finished with, and said that, if this simple precaution had been observed, 25 lives would have been saved in 1959.

Excessive energy

He expressed his belief that many of the persons who were killed by electricity actually died from suffocation, as the shock was of short-term effect but in the moment of unconsciousness the victim often fell on his back, which resulted in the tongue falling back and blocking the windpipe. He therefore laid great stress on the necessity of immediately getting the patient on his face. He also warned against excessive pressure being used when applying standard methods of artificial respiration, in order to avoid the risk of staving-in the ribs, which post-mortem examination had shown in many cases to have occurred, owing to over-energetic treatment.

When discussing fires, he pointed out that, although the

total of those associated with electric cookers showed an upward trend, the rise followed the increase in the number of cookers in use, and also the fires were largely due to causes common to all forms of cooking stove, irrespective of the fuel employed, such as the burning of food, and, therefore, had no direct electrical significance.

Many of the typical accidents described by the lecturer were prominently depicted in illustrations which adorned the walls of the Theatre, and a number of practical demonstrations were given of how accidents occur and of their effects.

One of the most fascinating, if somewhat gruesome, features of the lecture was the assembly of a large quantity of the actual electrical appliances etc. which had been associated with particular electrical fatalities, and this certainly gave added point when they were being individually referred to by the lecturer.

A well deserved vote of thanks, accompanied by great acclamation, was accorded to Mr. Emerson by his appreciative audience for his very interesting lecture.

R. H. R.

VISIT TO CAMBRIDGE

On Saturday, 21st May 1960, the weather forecast for East Anglia was: cloudy, rain or drizzle; wind mainly light; maximum temperature 58° F. Fortunately, the Section members visiting Cambridge did not have the most unpleasant part—rain or drizzle—and, although cool conditions warranted coats and ready umbrellas, the programme was fulfilled extremely pleasurably and without discomfort created by the weather.

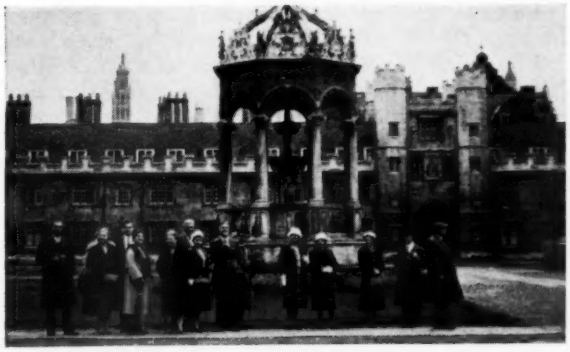
About 150 members and ladies attended, and, after a welcome by Mr. C. W. Oatley and coffee thoughtfully provided in the Department of Engineering of the University, the ladies departed to visit the nearby Fitzwilliam Museum while their menfolk proceeded on a tour of the department.

Engineering has been taught in Cambridge since about 1800; and, after the laboratories in the centre of the city had been outgrown, the present site was bought in 1920, and construction still proceeds with the continual expansion. Several buildings, including the main five-storey Baker Block, now house the department. A staff of 240 provide tuition for those students selected by their various colleges, about 840 reading engineering. In addition, some students are engaged on research leading to higher degrees, and most of the staff are also pursuing their own research projects.

Other students, having spent a period in industry, are taking postgraduate courses preparatory to their return, having studied the latest advances in knowledge in their respective fields of application. Many members would have preferred to have spent days rather than hours in the department, and it is certain that all were considerably impressed by the scope of the tuition available and the nature of the equipment. Moreover, it is felt that many would have liked to have rolled back the years and have their youth with the opportunities for study which were so invitingly available.

Tour of the colleges

The ladies, having spent the morning gently on their visit to the museum or in converse, headed for the University Arms Hotel to become, with the members, the guests of the Eastern Electricity Board. An excellent lunch was provided and was rounded off by the Chairman of the Section, Dr. J. R. Mortlock, expressing appreciation for the arrangements made



Great Court, Trinity College, Cambridge

to Mr. H. V. Pugh, Chairman of the Board, and his colleagues. Mr. Pugh responded by indicating the pleasure afforded him in welcoming so many friends from the Section.

Although the afternoon continued dull in weather, dullness did not apply to the itinerary of the colleges and the most delightful Round Church. Names of colleges such as St. John's, Trinity, King's and Queens' require only mentioning to conjure up some measure of the background and full past which become the inheritance of those 'going up'.

The architectural and academic treasures which abound can receive only a scanty appreciation in two hours, but sufficient was shown to cause the 'first time' visitor to wish to renew acquaintance and those who had been before to find fresh points and places of interest. The guides, by their intimate knowledge of the colleges and their precincts, provided historical and factual details which were enhanced by light elements relating to past escapades and other aspects of college life.

All the arranged paths of the tour led ultimately to tea, taken at the Garden House Hotel, which ended a most enjoyable visit.

Once again your reporter is indebted to the member who can work in the poetic vein and express in verse his impressions of the visit.

F. C. W.

Supply Section visit to Cambridge, 1960

At Cambridge on a day in May
We landed at the station,
With ladies 'radiating' charm
To grace the glad occasion.

The members saw, and much admired,
Th'Department Engineering;
The ladies to 'Fitzwilliam' went
Till luncheon time was nearing.

We then unto Th' Vars'ty Arms
In groups did slowly hie,
As guests of the kind Eastern Board
Who laid on the 'supply'.

So Dr. Mortlock tendered thanks,
And Mr. Pugh replied,
'We hope you'll come again', quoth he,
'Indeed, we will', we cried.

Then many colleges we viewed—
Those ancient seats of learning—
Two hours we took to visit them,
And for a rest were yearning.

So, on for tea at 'Garden House',
Which we all felt we'd earned,
Then 'way back home, with knowledge 'charged',
Best thanks to all concerned.

Shylock

Reflections in the Cam

ELECTRONICS AND COMMUNICATIONS

HENRI DE FRANCE COLOUR TELEVISION

HISTORY was made at Savoy Place on the 27th April 1960, when MM. R. Chaste and P. Cassagne presented their paper 'Henri de France colour-television system', which is reviewed on p. 490. For the first time, colour television was successfully demonstrated over the Eurovision network between Paris and London; and the fact that it was a 625line arrangement added to the novelty of the occasion. Most appropriately, Mr. M. J. L. Pulling, who has been so intimately concerned with the progress of Eurovision since its inception, was in the Chair.

M. Chaste began by comparing features of the Henri de France method with corresponding features of the N.T.S.C. system. Before proceeding, he explained that, since it was hoped that the method would be adopted by other countries, it had been decided to rename it the SECAM system. In common with the N.T.S.C. method, the SECAM system is a compatible one, employing a standard luminance signal and a chrominance signal comprising two colour-difference signals which are conveyed by a subcarrier.

The principal difference is that, with the SECAM method, the two colour-difference signals are transmitted sequentially, alternating at line frequency, so that conventional modulation and detection of the colour subcarrier can be used. By an ingenious application of a delay line in the receiver, the two colour signals are in fact reproduced simultaneously, one being derived from the 'previous' line. The price paid for this (apart from the cost of the delay line) is a reduction in vertical colour-resolution, but, as the human eye cannot see colour in fine detail, this can only be regarded as efficient exploitation.

Demonstration

Two 21 in. colour receivers were used for the demonstration; and, while the colour pictures may not have been the best we have seen, they were remarkably good, bearing in mind the length and complexity of the network through which they had travelled. Two versions of the system were demonstrated —first with the colour subcarrier amplitude-modulated and second with it frequency-modulated. In each case, a number of slides were shown, followed by a short colour-film.

It was clear from the demonstration that the SECAM method is not affected by differential-phase distortion; but of course it was not possible, even at the front of the Lecture Theatre, to judge the finer points, such as vertical resolution, visibility of the colour subcarrier, signal/noise ratio, etc. It was, however, pointed out that the f.m. version gave a better signal/noise ratio but resulted in greater visibility of the colour subcarrier.

During an interval while the system was being changed from a.m. to f.m., Mr. W. J. Bray gave a very interesting discourse on the Eurovision network which was used for the demonstration. After congratulating the authors, he gave details of the over-all performance of the network, which involved 12 microwave links handling a video bandwidth of

5Mc/s. He mentioned that the Institution building was now connected by permanent 5Mc/s wideband coaxial-cable link to the national television distribution network, so that in future members would have the advantage of that facility.

The discussion was opened by Mr. V. J. Cooper, who made the pertinent comment that the SECAM method came nearer to being a serious competitor to the N.T.S.C. system than anything seen so far. Other points of interest were raised by Mr. Cooper and by a number of other speakers who contributed to a lively discussion. Dr. R. D. A. Maurice took part and also translated a contribution from M. R. Sueur, which opened with greetings from the French Post Office.

In closing the meeting, the Chairman emphasized the need for a common standard when colour comes to Europe. On behalf of all present, he congratulated the authors most sincerely on their considerable achievement. G. G. G.

SOVIET CONTROL-ENGINEERING PROGRESS

In May 1959, The Institution, in co-operation with the British Council, arranged for a visit to Russia of six engineers concerned with industrial applications of automatic control. Their observations were briefly reported in the September 1959 *Journal*, p. 521, and a more complete report is available on request from the British Conference on Automation and Computation.

The meeting of the Measurement and Control Section at Savoy Place on the 16th February 1960 provided an opportunity for discussion both of the findings of this team and of Soviet technical progress in general. Six speakers gave introductory contributions and, as they all took longer than expected, the time for general discussion was limited; nevertheless, the symposium did build up a vivid picture of the considerable achievement and significance for the future of Soviet work on control.

The topic was introduced by Mr. R. E. Clark, who reviewed the general background of the organization of engineering research and education in Russia. He raised, in particular, the controversial question of the extent to which the massive provision for technological education and for research and development might bring Russia into international trade as a powerful competitor with the West. Discussion of this aspect revealed no doubt that Soviet achievements would equip them to compete, but suggested that the extent to which they could do so would depend on their willingness to buy as well as to sell.

The mass production of certain standardized articles, e.g. particular machine tools, in particular factories, whether in the United States, the Soviet Union or elsewhere, was a possible outcome of the new technical possibilities of cheap automatic production, and was a problem that would require solution whether or not the competing countries included the Soviet Union. The special feature in the Soviet case was the possibility of such competition being influenced by political as well as purely economic considerations.

Mathematical analysis

The following three speakers, Mr. R. H. Tizard, Mr. S. S. Carlisle and Mr. A. Asbury, were members of the team that visited the Soviet establishments dealing with automatic control. They referred respectively to digital techniques, to the steel industry, and to work relating to electrical power and instrumentation. The general picture presented was of the Soviet engineers, having now taken their place in the front line of progress, being ahead in certain spheres in which their special needs had stimulated special efforts.

Mr. A. T. Fuller then contributed a brief review of the Soviet contribution in a field in which they may fairly claim to excel, namely the development of the mathematical analysis of the behaviour of non-linear systems subject to random disturbance. He gave a brief account of recent work on statistical mechanics, particularly by Pontryagin, and showed how Russian mathematicians were bringing new and powerful methods, based on statistical mechanics and the variational calculus, to bear on control problems. The potency of the mathematics was clear. The precise outcome for such problems as the control of a particular chemical process remained somewhat obscure.

Finally, Dr. D. J. Urquhart, of the D.S.I.R. library service, spoke on the means now available to English-speaking engineers to maintain contact with Soviet work through Russian publications, and outlined the provision now made by D.S.I.R. and other bodies for translation and publication in English of selected Russian material.

The time left for general discussion was short, but was sufficient to show the great interest of the large audience in the need for contacts and co-operation with Soviet engineering. Several speakers referred to the need for more engineers to learn to read and speak Russian. A. T.

DIGITAL COMPUTERS AT MANCHESTER

A meeting entitled 'Digital-computer developments at Manchester University' was held at Savoy Place on the 1st March 1960, under the Chairmanship of Prof. A. Tustin.

The large audience heard Prof. T. Kilburn, well supported by colleagues from Manchester, start with a concise yet interesting history of digital computers, emphasizing how operating speed and storage capacity had been increasing over the past 15 years. There was great interest in some details of the latest British computer project MUSE, currently under development by the University.

Three papers directly concerned with this project were presented. The first, entitled 'A digital-computer store with

very short read-time' (reviewed on p. 492), by T. Kilburn and R. L. Grimsdale, gave an account of a semipermanent store, in which first the wires are woven to the desired pattern and then the digits are stored by mechanically locating the ferrite rods at the address locations where 1's are required.

The second contribution, 'Ferrite-core memory systems with rapid cycle times' (see p. 496 for synopsis), by D. B. G. Edwards, M. J. Lanigan and T. Kilburn, explained a novel design of magnetic-core store in which high operating speed is achieved by using two cores per bit. This arrangement results in a constant loading on the drive circuits, an improved digit discrimination and a lower power demand compared with one-core-per-bit systems of comparable speed.

A third paper, by T. Kilburn, D. B. G. Edwards and D. Aspinall, dealt with 'A parallel arithmetic unit using a saturated transistor fast-carry circuit' (a synopsis appears on p. 496). This showed how, by adapting a circuit first developed for use with relays, a carry propagation time limited only to the delay introduced by the connecting wires can be obtained.

Finally, Prof. Kilburn presented some work from a different section of his department, described in the paper 'High-speed light output signals from electroluminescent storage systems', by G. R. Hoffman, D. H. Smith and D. C. Jeffreys. This paper, which is reviewed on p. 491, examined the problems associated with the use of an electroluminescent panel as a permanent store, and was illustrated by several working examples of electroluminescent panels.

Ten times faster

The meeting was well attended by many engineers engaged in the computer field, whose comparative youth was the subject of comment by the Chairman. Some diffidence in taking part in the discussion was apparent, which was disappointing, since it would appear likely that comparison between MUSE and other high-speed computers under development would have been useful.

Prof. Kilburn was asked to give some estimate of the future trend in computers and computer components, but he would go no further than to predict that he would be concerned with a generation of computers ten times faster than MUSE.

The meeting was most instructive, and the audience left with the feeling that much progress would be made in the computer field in the next few years, and that Manchester University's new Department of Computer Engineering would remain well to the fore in developing new techniques.

F. J. W./R. E. H.

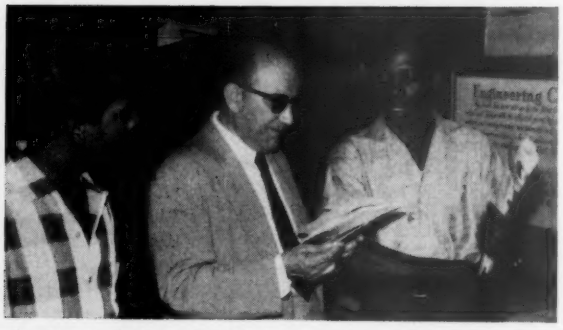
News from abroad

TRINIDAD AND TOBAGO JOINT GROUP

Caribbean Exhibition

MAY 1960 was a very active month, involving a great deal of hard work for many members. The main reason was the Caribbean Exhibition 1960, which was held in Port-of-Spain from the 6th to 22nd May. The Joint Group organized and staffed a booth, at which advice on engineering careers was given to interested schoolboys, young men, parents, school-teachers, etc. The booth was staffed each day the exhibition was open by three members from each of the three Institutions, and inquiries were numerous and varied.

While the results have not yet been fully analysed, it is felt that a great deal was achieved, not only in explaining to those interested the proper course to pursue towards a professional engineering career, but also in obtaining a very good idea of the misconceptions in the public mind regarding engineers and engineering.



On the stand of the Trinidad and Tobago Joint Group at the Caribbean Exhibition 1960, Mr. L. G. Felipes explains a point to inquirers

Mr. David Key was responsible for all the organization, ably assisted by Mr. A. I. H. Scott and Mr. L. G. Felipes. As part of the scheme, all three members were interviewed on a broadcast programme. Without the enthusiasm and hard work put into it by this sub-committee, the venture would not have been the success it was; and our grateful thanks are due also to the firms, big and small, who gave or lent materials, furniture and labour. Finally, we thank those who spent many hours on duty in rather humid conditions.

Penal power station

On the 28th May 1960, a successful visit was paid to see development work in progress at the Penal power station of the Trinidad and Tobago Electricity Commission, where a 20 MW turbo-alternator is in course of installation. The development is in a most interesting stage, and it was possible to see the 'insides', so to speak, of the turbine and boilers. The station uses natural gas for fuel at present, at the rate of 7 million ft^3/day, and produces $3\frac{1}{2}$ million kWh/week.

Another recently completed installation seen was the Moora Dam, which retains the reservoir for a pumped-storage cooling-water scheme. The dam can retain 200 million gal, which can be supplied to the station at the rate of 1 million gal/day.

The station superintendent and Mrs. Chown provided a thoroughly unusual and delightful tea after the visit, which gave a welcome opportunity for discussion. D. P. J. H.